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W1. Pre-Conference Workshop—Equity and Ethics Committee Sponsored
Equity Internationally – Scholarship, Research, and Service for a Global Science Education Community

8:00am – 12:00pm, Curacao 1

Geeta Verma, Georgia State University
Regina E. Wragg, University of South Carolina
Jerome M. Shaw, University of California, Santa Cruz
Gillian U. Bayne, Lehman College of the City University of New York
Nate Carnes, University of South Carolina
Sumi Hagiwara, Montclair State University
Maria S. Rivera Malucci, Barnard College
Felicia Moore-Mensah, Columbia University
Jomo W. Mutegi, Indiana University -- Purdue University Indianapolis
Wesley Pitts, Lehman College of the City University of New York

ABSTRACT: The Equity and Ethics Committee sponsors this pre-conference workshop for scholars of color and individuals interested in scholarship involving equity in science education. Workshop participants will network with facilitators representing the spectrum of career stages of scholars in science education. Attendees will also engage in discussion regarding science education in the international community and the opportunities and challenges available to scholars of color and individuals interested in researching science education equity issues.

W2. Pre-Conference Workshop—Publications Committee Sponsored
Developing High Quality Reviews for the Journal of Research in Science Teaching

8:00am – 12:00pm, Curacao 3

Angela M. Calabrese-Barton, Michigan State University
Joseph S. Krajcik, University of Michigan
Bob Geier, University of Michigan
Patti Bills, Michigan State University
Hayat Hokayem, Michigan State University

ABSTRACT: The purpose of this session 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 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.

W3. Pre-Conference Workshop—Research Committee Sponsored
Developing a Competitive Educational Research Proposal for NSF's Division of Research on Learning

8:00am – 12:00pm, Curacao 4

Gavin W. Fulmer, National Science Foundation
Janice Earle, National Science Foundation
Kusum Singh, National Science Foundation
Celeste Pea, National Science Foundation

ABSTRACT: This pre-conference workshop will provide researchers interested in submitting an educational research proposal to the NSF's Division of Research on Learning (DRL) an understanding of: • Contexts of STEM educational research in NSF and DRL • Characteristics of DRL's three major research programs: o Research and Evaluation in Education, Science and Engineering (REESE); o Discovery Research K-12 (DRK-12); and o Faculty Early Career Development (CAREER) • NSF's proposal review process and merit review criteria • Characteristics of competitive

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proposals • Common weaknesses in poorly-rated proposals The workshop will begin with an informational session and then break into small groups. The groups will read, review, and discuss brief scenarios—passages from proposals that demonstrate strengths and weaknesses in addressing the merit review criteria—in one session. In another session, the group members will have opportunity to discuss their research ideas with DRL Program Officers (POs) and other attendees. Please come with a 250-word summary of your idea to discuss. Individuals new to proposal-writing are encouraged to attend.

W4. Pre-Conference Workshop—Research Committee Sponsored
Developing and Assessing Learning Progressions in Science

8:00am – 12:00pm, Curacao 5

Duncan Ravit Golan, Rutgers University

Joseph S. Krajcik, University of Michigan

David Fortus, Weizmann Institute of Science

Katherine L. Mcneill, Boston College

Julia D. Plummer, Arcadia University

ABSTRACT: Learning progressions (LPs) describe the ways in which learning of core scientific ideas and practices develop over extended periods of time (months to years) in the context of carefully designed instruction. LPs have the potential to provide greater coherence in learning across grades and grade bands, and better alignment between standards, curriculum, and assessment. Recently LPs have received much attention in the research and policy arenas; in particular they form the backbone of the Conceptual Framework for the New Science Education Standards. The LP scholarship has also grown substantially over the past 5 years and promises to continue expanding. This workshop aims to provide newcomers to LP research with an introduction to the development and assessment of LPs. The workshop includes three parts that each deal with an important aspect of developing and validating LPs: (a) developing construct maps, (b) item design, scoring, and the measurement model, (c) designing LP-driven instruction (and PD) to test LPs in real-world science classrooms. Participants will work in small groups using data from various existing LP research projects to explore these three aspects of LP research and development. We expect participants to leave the workshop with a strong conceptual foundation for thinking about and engaging in LP research. Participants will receive a set of workshop materials containing explanations of core concepts, examples, and a list of web sites with resources for LP research, as well as have an opportunity to network with others in the expanding LP research community.

W5. Pre-Conference Workshop—Research Committee Sponsored

Videocase-based Lesson Analysis of Science Teaching to Support Teacher Learning: Experiencing Lesson Analysis and Mapping a Program of Research

8:00am – 12:00pm, Curacao 7

Kathleen Roth, BSCS

Meridith Bruozas, BSCS

Elaine Howes, BSCS

Paul Numedahl, BSCS

Kathleen Schwille, National Geographic

ABSTRACT: This workshop will examine the analysis of videocases of science lessons as a core part of inservice and preservice teacher learning programs. There will be two main workshop activities: 1) First-hand experience with an online video analysis program designed for K-8 preservice teachers*, and 2) Facilitated, small group discussions that will challenge participants to examine and modify a draft visual/map representing a program of research about teacher learning from analysis of videocases. The Videocases for Science Teaching Analysis project (ViSTA) developed four online videocase modules for use as supplements in K-8 science methods courses*. In Part I of this workshop, participants will use selected ViSTA videos and tasks to experience the kinds of in-depth conversations that are possible when teachers have a shared context to examine (the videocases), a shared conceptual framework, and a shared protocol for analysis of the videocases. Part 2 of the workshop focuses on research in this area. Working in facilitated groups of 6-8,

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participants will examine, critique, and modify a draft visual/map that highlights the existing research and identifies gaps in our knowledge in this area. The following questions will guide the research discussion groups: • What do we know, what don't we know, and what do we need to know about teacher learning from videocase analysis? • How does research on teacher and student learning inform the use of videocase analysis in teacher learning programs? • How can the use of videocases (practice) inform research and deepen the knowledge base about effective approaches for preparing science teachers? Each group will be challenged to modify the visual to map a strong proposed program of research in this area.

Presidential Sponsored Session

S1.1 Symposium – Inquiry to Practices: Data Modeling, Measurement and Representation in Children's Statistical/Probabilistic Reasoning in Maths/Sciences

1:00pm – 2:30pm, Antigua 1

Presider: Richard Duschl, Penn State University

Discussant: Leona Schauble, Vanderbilt University

Presenters:

Cliff Konold, University of Massachusetts, Amherst

Richard Lehrer, Vanderbilt University

William A. Sandoval, UCLA

James Hammerman, TERC

ABSTRACT: The National Research Council synthesis research report Taking Science to School, the companion practitioners' report Ready Set Science! and the draft Core Science Framework all advocate a shift in science learning from a focus on inquiry to scientific practices. This shift is best understood as a call for coordinating inquiry with the practices by which inquiry advances. This Presidential session will examine practices of data modeling that align inquiry with ways of structuring, representing and modeling variability. The first presenter will describe the role of data modeling in contemporary practices with children. The remaining presenters will suggest a prospective learning progression that describes the seeds of these forms of practice and suggests how they might be supported in K-12 education. Examining new tools for and new understandings about students reasoning about and representation of data systems, the presenters will advance a position that data and statistics ought to be a central to learning in K-12 science education.

Strand 1: Science Learning, Understanding and Conceptual Change

S1.2 Symposium – Examining Learning Progressions beyond Content: Strands of Scientific Proficiency

1:00pm – 2:30pm, Curacao 1

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

Discussant: Joseph S. Krajcik, University of Michigan

Presenters:

Julia D. Plummer, Arcadia University,

Ravit Duncan, Rutgers University

Christina V. Schwarz, Michigan State University

Philip Bell, University of Washington

Nancy B. Songer, University of Michigan

ABSTRACT: There has been a recent proliferation of research on learning progressions (LPs) in science education as a way to influence the development of more coherent curricula and assessments. The recent draft of the Conceptual Framework for the New Science Education Standards also employs LPs as an approach to identify and organize the core ideas in science. While many LPs integrate big ideas in science content with cross-cutting themes of scientific practice, they do so in a variety of ways and to various extents. This symposium will examine issues relating to the integration of content-focused and practice-focused LPs with the other strands of scientific proficiency. The strands of proficiency refer

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to interest development, content learning, learning to reason, developing an understanding of the enterprise, learning to engage in disciplinary practices, and coming to identify with science (NRC, 2007, 2009). Presenters will discuss attempts to integrate different LPs with the strands as well as the theoretical challenges in developing such integrated LPs. Presenters will also address ways that the design of learning environments and associated products (e.g., curriculum, assessments, out-of-school programs) could benefit from attending to learning strands that have typically not been strongly emphasized in LP research and development efforts.

Strand 1: Science Learning, Understanding and Conceptual Change

S1.3 Related Paper Set - Pathways to Ecological Literacy: Developing a Biodiversity Learning Progression

1:00pm – 2:30pm, Bonaire 4

ABSTRACT: We report our progress in developing a biodiversity learning progression framework for middle and high school students. Using the learning progression approach, we documented pathways students take to achieve ecological literacy within several key areas of biodiversity. We administered written assessments to 937 middle and high school students in 5 states and interviewed a subset of those students. Upper level students integrated multiple principles that govern the presence of biodiversity and change in diversity over time, whereas lower level students failed to recognize diversity at multiple levels, failed to account for appropriate time scales, and did not utilize biodiversity principles. In addition to defining biodiversity learning progressions, these results suggest fundamental patterns in student reasoning that may underlie much of the problematic biodiversity content, including reasoning at inappropriate scales, viewing organisms as actors with anthropomorphic motives and failing to account for indirect organism interactions. The individual papers in this set provide detailed analyses of our findings and suggest learning progressions leading to literacy within key areas of our framework.

S1.3.1 Development of a Grade 6-12 Learning Progression for Biodiversity: An Overview of the Approach, Framework, and Key Findings

Laurel M. Hartley, University of Colorado Denver
Charles W. Anderson, Michigan State University
Alan Berkowitz, Cary Institute of Ecosystem Studies
John C. Moore, Colorado State University
Jonathon W. Schramm, Michigan State University
Scott E. Simon, University of California Santa Barbara

S1.3.2 The Understanding of Genetic Diversity in Student Accounts

Shawna K. McMahon, Colorado State University
John C. Moore, Colorado State University

S1.3.3 The Role of Heredity and Environment in Students' Accounts of Adaptation by Selection and Phenotypic Plasticity

Jennifer Doherty, Michigan State University
Charles W. Anderson, Michigan State University

S1.3.4 Using Complexity in Food Webs to Teach Biodiversity

Cornelia Harris, Cary Institute of Ecosystem Studies
Alan Berkowitz, Cary Institute of Ecosystem Studies

S1.3.5 Student Understanding of Species Diversity in Ecosystems

Brook J. Wilke, Michigan State University
Charles W. Anderson, Michigan State University

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Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.4 Approaches to Exploring Teachers' Roles

1:00pm – 2:30pm, Curacao 2

Presider: Allison Antink, Illinois Institute of Technology

S1.4.1 An Informal Educator and a Classroom Teacher's Perceived Roles during an Elementary Classroom Science Program

Ingrid S. Weiland, Indiana University, Bloomington, iweiland@indiana.edu

Kristin L. Cook, Indiana University, Bloomington

ABSTRACT: The purpose of this study was to investigate the goals and perceived roles of an informal science educator and an elementary classroom teacher during a series of lessons to promote environmental stewardship and to teach science content standards. Exploring these goals and perceived roles is of interest because informal educators and classroom teachers may offer different funds of knowledge (informal educators are familiar with content and context, while classroom teachers have unique knowledge about their students). Through qualitative methods, we found that both educators' roles evolved over the course of a six-session ecology unit and that their goals differed. We also found that a number of obstacles to implementing the unit existed. Finally, we recommend future investigations that offer support for explicit collaboration between formal and informal educators.

S1.4.2 Effect of Teacher Reasoning Ability on Student Learning

Jennifer L. Esswein, The Ohio State University, esswein.5@osu.edu

Jerome Mescher, Hilliard City Schools

Bruce R. Patton, The Ohio State University

ABSTRACT: The qualities which enable a teacher to be effective with students have been an enduring question in science education research. In particular, the roles of a superior content knowledge, of pedagogical content knowledge, and of experience in teaching have been identified as important factors. The present study seeks to examine the role of teacher reasoning ability on the development of both scientific reasoning ability and content knowledge gain in the students they teach. Results indicate that teachers' scientific reasoning ability, as measured by a multiple choice test, correlates extremely well with the measured scientific reasoning ability of the students they have taught. The significance of this on the training of pre-service teachers as well as the professional development of in-service teachers is discussed.

S1.4.3 An Exploration of Teacher Involvement in County Science Fairs: Student Support and Curriculum Integration

Kathleen Fadigan, Pennsylvania State University, kxf24@psu.edu

ABSTRACT: Science fairs are extremely popular activities in K-12 science education, but very little research has been conducted regarding the participants and any potential benefits. This exploratory pilot study provides a preliminary profile of science teachers' roles in supporting students in the science fair process and their opinions on whether or not science fairs should be part of the curriculum. This research also reports on teachers' perceptions of the benefits of science fair participation. Fifty-two teachers representing six county-level science fairs completed an on-line questionnaire. Results reveal that teachers vary widely in the level of involvement. Teachers mentor from one to more than twenty students per year. The number of times teachers met with students varied from only two times up to daily meetings. Seventy-three percent of respondents stated that science fairs should be incorporated into the science curriculum, yet less than half made participation mandatory for their students in 2009. Perceived benefits include development of communication and organizational skills, exposure to science careers, and opportunities to pursue authentic science investigations that are of personal interest.

S1.4.4 Teacher Hedging and the Tentative Nature of Science Inquiry Discussions

Huseyin Colak, Northeastern Illinois University, h-colak@neiu.edu

Alandeom W. Oliveira, State University of New York at Albany

Valarie L. Akerson, Indiana University

Khemmawadee Pongsanon, Indiana University

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Abdulkadir Genel, Indiana University

ABSTRACT: The present study explores the use of hedges -- noncommittal words and expressions that are characteristically vague, indirect, and unclear -- by elementary teachers facilitating science inquiry discussions prior and subsequent to their participation in a summer institute designed to improve their awareness of hedging. Two specific forms of teacher hedging are comparatively examined: plausibility shields (expressions such as "I think," "maybe," "probably," and "possibly" that communicate tentativeness and doubt about the validity of claims being made) and approximators (terms such as "approximately," "roughly," "somewhat," "often," and "occasionally" that insert vagueness and imprecision to quantitative claims). Our findings revealed that teachers' employment of plausibility shields was substantially more frequent during implementation of the post-institute inquiry lessons, suggesting that teachers adopted oral practices with a higher degree of tentativeness after the institute. In contrast, teachers' use of approximators did not change substantially, indicating that the level of vagueness and imprecision of teachers' oral practices remained unaffected. It is argued that teachers need to become more aware of the different hedging forms available for science instruction, their affordances and constraints, their potential as tools for conveying the tentativeness of science as well as the risk of "nature of science" miscommunication.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.5 Related Paper Set - Strategies for Fostering Discussion for Model Based Learning in Science

1:00pm – 2:30pm, Bonaire 8

Presider: John J. Clement, University of Massachusetts - Amherst

Discussant: Philip H. Scott

ABSTRACT: A large set of model-based teaching strategies gathered over a period of several years from classroom observations, transcript analyses, and teacher interviews are examined through multiple lenses. Study 1 describes teaching strategies that experienced high school physics educators utilized during whole-class discussions to engage their students in the construction of explanatory mental models. These fell at distinct levels including dialogic and model construction levels. Study 2 uses comparative case studies to describe and compare large group discussion strategies used in computer simulation and static overhead based lessons. It suggests that a simulation can be useful not only because it has a dynamic mode but also because it has a static mode. Study 3 uses comparative case study analyses to compare teacher and student strategies for using interactive simulations in either small group or whole class settings in high school physics. It considers possible explanations for why the hands-on small group work did not produce better results than the whole class work. Study 4 describes the process by which many of the strategies for using simulations were gathered and how they were organized using teacher feedback. It also highlights some trends that were observed in the strategies themselves.

S1.5.1 Multiple Levels of Discussion-based Teaching Strategies for Supporting Students

E. Grant Williams, University of Massachusetts - Amherst School District 18 - Fredericton, New Brunswick, Canada

S1.5.2 Comparative Case Studies of Discussion Strategies used in Dynamic Computer Simulation vs. Static Image-based Sessions

Norman Price, University of Massachusetts - Amherst

S1.5.3 Hands on Small-group vs. Whole-class use of Animations and Simulations: Comparative Case Studies in Projectile Motion

A. Lynn Stephens, University of Massachusetts – Amherst

S1.5.4 Discussion-based Strategies for use of Simulations and Animations in Middle and High School Science Classrooms

Abi Leibovitch, University of Massachusetts – Amherst

A. Lynn Stephens, University of Massachusetts – Amherst

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Norman Price, University of Massachusetts - Amherst

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

S1.6 Elementary Teacher Content Knowledge

1:00pm – 2:30pm, Curacao 3

S1.6.1 Using Research-based, Inquiry Physics Experiences (RIPE) to Improve Pedagogy Practices and Improve Content Knowledge of K-3 Teachers

Stephen J. Van Hook, Penn State University, sjv11@psu.edu

Tracy L. Huziak-Clark, Bowling Green State University

ABSTRACT: This paper describes an instructional model for aiding early childhood teachers (grades K-3) to develop conceptual models of physics concepts for themselves and their students. This model has evolved from a seven-year collaboration between a university physics professor, science education professor and a collaborative field elementary school to develop and test lessons in physics concepts for early childhood students. Drawing upon these lessons, we developed a summer institute and year-long professional development program to teach K-3 teachers grade-level-appropriate physics content using this teaching model, and to assist them in using this model to teach their own students during the academic year. This paper focuses on the classroom enactment of these lessons and the impact on teacher confidence teaching physical science via inquiry, as well as the content gains made by the participants after the summer workshop and implementation in their own classrooms.

S1.6.2 Increasing Science Teaching Efficacy Beliefs among Elementary Teachers through Content Knowledge Improvement

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

Marykay Orgill, University of Nevada Las Vegas

Kristoffer R. Carroll, Clark County School District

ABSTRACT: This study aimed to answer the following research questions: (1) To what extent elementary teachers can improve their science content knowledge of energy as a result of a 5-day intensive summer institute designed to improve their science content knowledge about energy? (2) To what extent a 5-day intensive summer institute designed to improve elementary teachers' science content knowledge can improve elementary teachers' science teaching efficacy beliefs? We found that participants were able to improve their science content knowledge about energy and participants science teaching efficacy beliefs improved significantly at the end of the professional development program. Results of this study indicated that professional development programs designed to improve elementary teachers' science content knowledge can also improve their science teaching efficacy beliefs.

S1.6.3 Impact of Teachers' Physics Content Knowledge on Quality of Teaching and Students' Achievement during the Transition between Elementary and Secondary School

Annika Ohle, University Duisburg- Essen, Annika.Ohle@uni-due.de

Hans E. Fischer, University Duisburg- Essen

ABSTRACT: International large-scale assessments have shown a decrease in students' achievement during the transition from elementary- to secondary school. There are indications that teachers' professional knowledge impacts the quality of teaching and students' outcomes. The goal of the study presented here is to assess teachers' content knowledge (CK) on the topic "states of matter and phase transitions" and identify aspects of this knowledge in the lessons. A test has been developed to measure teachers' CK. Quality of teaching is analyzed using videotaped science lessons in elementary school (grade 4) and lower secondary school (grade 6), focusing both on their content structure and the cognitive structure. Multilevel analyzes reveal that teachers' CK, which is mediated by the cognitive structure of the lesson, is a significant positive predictor for students' outcomes in elementary school science classes. Results from secondary school physics classes will be presented at this conference.

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

S1.7 Strand Sponsored Session-Twenty First Century Skills: An International Perspective

1:00pm – 2:30pm, Curacao 4

Presenters:

Danielle Dani, Ohio University, dani@ohio.edu
Saouma B. Boujaoude, American University of Beirut
Sara Salloum, Long Island University
Anil Banerjee, Columbus State University
Rola Khishfe, American University of Beirut
Kenneth G. Tobin, City University of New York

ABSTRACT: In the United States and around the world, calls for preparing “career and college ready” students are embedded in the emphasis on 21st century readiness. This symposium discusses 21st century skills and their implications for secondary science education in the international arena. Panelists will first define 21st century skills and learning using multiple frameworks (including the Partnership for 21st century skills, OECD, and others) and share a framework that was specifically created for the analysis of secondary curricula and programs for their potential to promote 21st century learning and skills. Panelists then will share the results of standards, curricular, and/or program analyses using the study’s framework in the United States, the Middle East, and India. The symposium concludes with a comparative discussion of findings and future directions for the 21st century learning and skills movement in science education.

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

S1.8 Biology Instruction and Assessment

1:00pm – 2:30pm, Curacao 5

President: Janelle M. Bailey, University of Nevada, Las Vegas

S1.8.1 Classification of Undergraduate Alternative Conceptions of the Tricarboxylic Acid Cycle

Sara L. Johnson, The University of Southern Mississippi, Sara.Johnson@usm.edu

Jill D. Maroo, The University of Southern Mississippi

Learning Natural Selection in College Biology Courses: The Relationship Between Teaching Methods and Learning Gains

Tessa M. Andrews, Ecology Department, Montana State University, andrews.tessa@gmail.com

Mary J. Leonard, Education Department, Montana State University

ABSTRACT: Alternative conceptions are prevalent in today’s college-level introductory biology students. These alternative conceptions have implications not only on the student’s understanding of the topic at present, but they may also play a part in the student’s future learning. In this study, we create a taxonomy of alternative conceptions concerning the Tricarboxylic Acid (TCA) cycle. Ten students enrolled in an introductory biology course participated in individual semi-structured interviews lasting 30-60 minutes. Students used supplied vocabulary cards, sketch paper and writing instruments to complete the interviews. We identified student alternative conceptions using verbal responses to open ended questions with clarification through student illustrations and card placement. We found five alternative conceptions commonly held by students. We identified each alternative conception’s location within a triangle created by three levels of understanding. Students’ alternative conceptions existed within the microscopic and representational levels. We determined that the connection between these levels was absent in most students. Our work expands current understanding of alternative conceptions students hold concerning metabolic processes (Songer & Mintzes, 1994). This study provides insight in to the locations of alternative conceptions within the understanding triangle. This knowledge allows educators to anticipate obstacles their students may face in learning the TCA cycle.

S1.8.2 Naturalistic Inquiry of Introductory Biology Faculty Instructional Practices

Omah M. Williams, Texas A&M University, owillia2@tamu.edu

Tim P. Scott, Texas A&M University

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ABSTRACT: Science Technology Engineering and Math (STEM) faculty often influence the teaching practice of pre-service science teachers although they are trained to be researchers. College of education methods courses are designed to train pre-service science teachers, enhancing their understanding of subject matter structures and pedagogical content knowledge. This qualitative study uses naturalistic inquiry to interview n=5 introductory biology course faculty about their teaching practice and awareness of the presence of pre-service science teachers in their classes. An emergent paradigm was used to determine themes from unitized transcripts that were generated after each interview. It was found that the respondents often use lectures and stories to teach biology content. There were n=2 respondents that added that they used demonstrations to help students make connections and build personal subject matter structures. Their teaching practice demonstrated their pedagogical content knowledge. Only n=2 of 5 respondents were aware that they had pre-service science teachers in their courses, as they would review their rosters prior to the beginning of the semester. While all eluded that a review of their class roster would be used to help determine the instructional goals for their class, respondents all agreed that pre-service science teachers learned to teach from methods courses.

S1.8.3 The Effects of Argumentation via On-line Discussion in University Students' Informal Reasoning Regarding Genetic Engineering

Ying-Tien Wu, National Central University, Taiwan, ytwu@cl.ncu.edu.tw

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

ABSTRACT: This study aimed to investigate the effects of the use of anonymous on-line discussion on 37 university students' informal reasoning regarding a socio-scientific. In addition, such effects on students with different reasoning ability were also explored. The research treatments of this study were anonymous on-line discussion task. Before the conduct of this study, the participants' personal positions and informal reasoning regarding genetic engineering was assessed. The participants' personal positions revealed in the pre-test were used to assign them into on-line discussion groups. Each discussion group had four students, consisting of two students supporting genetic engineering and two students with the opposite position. The students were asked to discuss on "the use of genetic engineering in transplanted animal organs to human" anonymously in the on-line discussion forum in groups during the period of a week. After the conduct of on-line discussion task, the participants' informal reasoning regarding genetic engineering was assessed again. This study revealed the significant effects of on-line discussion task on improving the students' informal reasoning quality. More importantly, it was found that both the students achieving a "higher" reasoning level and those achieving a "lower" reasoning level benefited from the anonymous on-line discussion, but in different ways.

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

S1.9 Related Paper Set - Measuring Pedagogical Reform in Undergraduate Entry-Level Science Courses

1:00pm – 2:30pm, Bonaire 7

Presider: Dean Zollman, Kansas State University

Discussant: Cheryl L. Mason, San Diego State University

ABSTRACT: This paper set focuses on data collected nationwide as part of the 5-year National Study of Education in Undergraduate Science (NSEUS) project. The primary goal of this project is to measure standards-based reform of undergraduate entry-level science courses and its impact on students. The papers address how the manner in which these undergraduate science courses are taught influences K-6 teachers' understanding of scientific content, and provides models for the teaching and learning of science. NSEUS researchers conducted intense onsite visits that involved gathering interview, observation, and survey data from faculty, undergraduate students, and inservice elementary teachers to gain an in-depth, broad-scale picture of undergraduate science reform in the United States and its transcendence to the K-6 level. We will share some of the important knowledge gained from the NSEUS project concerning (1) measurement of the perceptions of the learning environment among students in undergraduate entry-level science courses; (2) students' reasoning skills as they apply to scientific concepts; (3) pedagogical content knowledge (PCK) of undergraduate science faculty as it relates to their teaching quality and to the PCK of inservice elementary teachers; and (4) the impact on elementary teachers' science teaching self-efficacy beliefs as compared to observed science teaching practices.

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S1.9.1 Measuring Perceptions of the Learning Environment in Undergraduate Entry-Level Science Courses

Cynthia S. Sunal, University of Alabama
Dennis W. Sunal, University of Alabama
Erika M. Steele, University of Alabama

S1.9.2 Assessing Students' Reasoning across Disciplines in Entry-Level Science Courses

Mojgan Matloob Haghanikar, Kansas State University
Sytil Murphy, Kansas State University

S1.9.3 Measuring Outcomes of Undergraduate Science Reform on Inservice Teacher's Pedagogical Content Knowledge

Donna Turner, University of Alabama
Dennis W. Sunal, University of Alabama
Cynthia S. Sunal, University of Alabama

S1.9.4 The Impact of Reformed Undergraduate Science Courses on Elementary Teacher Self-Efficacy and Science Teaching Practices

Corinne H. Lardy, San Diego State University

Strand 6: Science Learning in Informal Contexts

S1.10 Life after High School: How Informal Science Impacts STEMS Careers

1:00pm – 2:30pm, Curacao 6
Presider: Anita Welch, North Dakota State University

S1.10.1 Competitive Science Events and Academic Major Choice

Jennifer H. Forrester, The University of Wyoming, jforres5@uwyo.edu
M. Gail Jones, NC State University
Grant E. Gardner, East Carolina University

ABSTRACT: Understanding present barriers to choosing a STEM major is important for science educators so that we may better prepare and inspire future generations of scientists and engineers. This study examined the relationships between participation in competitive science event and choosing a STEM major. The participants included 1,488 freshman students at a large southeastern university. Students completed a survey of pre-college experiences with science events, science interests, and college major, as well as, an assessment of science self-efficacy. A subsample of sixty students (30 STEM; 30 non-STEM majors) were interviewed. Significant gender differences were found for academic major choice. Study participants also reported being motivated to choose a certain academic major as a result of intrinsic and extrinsic motivational factors.

S1.10.2 Out-of-School Time Science Activities and their Association with Career Interest in STEM

John T. Almarode, University of Virginia, jta7z@virginia.edu
Katherine Dabney, University of Virginia
Jaimie L. Miller, Harvard-Smithsonian Center for Astrophysics
Zahra Hazari, Clemson University
Robert H. Tai, University of Virginia
Philip M. Sadler, Harvard-Smithsonian Center for Astrophysics

ABSTRACT: One method of promoting advanced science education, student interest, and choosing a career in science has been the use of out-of-school time (OST) science activities. The proliferation of OST science activities or programs has been due to a variety of influences, including government funding, efforts to provide a safe environment for children of working parents, remedial education designed to meet the requirements of Annual Yearly Progress (AYP) and, perhaps most importantly, the reported efficacy of OST science programs on students. Studies have shown that the

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potential for academic success is significantly improved with involvement in these programs, in terms of higher GPAs, higher attendance, lower drop-out rates, better attitudes toward school and learning, more frequent completion of homework and projects and higher standardized test scores. This study investigates the association between participation in OST science activities and STEM career interest in college. Results suggest that student participation in OST science activities is positively associated with STEM career interest. However, the results from this study also suggest this may be due to a self-selection effect.

S1.10.3 Seeing Science as Part of Who You Are: Initial Impact of a STEM-focused Out-of-School Program

Patrik Lundh, SRI International

Melissa Koch, SRI International, melissa.koch@sri.com

Christopher J. Harris, SRI International

ABSTRACT: Girls enter middle school with relatively high levels of self-confidence and interest in science and mathematics, but in the absence of effective interventions these tend to decrease over the middle and high school years. To increase the value girls see in pursuing science and mathematics careers, researchers hold that girls need to have meaningful interactions with STEM role models, see their own interests reflected in STEM experiences in both formal and informal learning settings, and have the opportunity to make connections between STEM and their own lives such that they come to see science as a central part of the “girls who they are”. We report on the first year piloting of an out-of-school intervention designed to increase high school girls’ awareness and value of science and science-related careers as well as increasing girls’ expectations of success in science. Based on research on girls’ identity and professional choices, the intervention aims to intrigue and challenge high school girls to address community-relevant environmental issues by developing ecologically sustainable innovations. Findings from the first year of enactment show that while girls’ confidence and interest in math and science learning and careers are improving, their interest in school mathematics and science is declining.

S1.10.4 I know what my Carbon Footprint is! Impact Analysis of a High-School

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

Ann House, SRI International

Aisha Heredia, SRI International

ABSTRACT: This paper shares evidence on the program evaluation of an informal science program for high school female students that attempts to address the gender inequity in STEM fields. The intended programmatic outcomes include raising girls’ confidence in these fields, exposing them to STEM career and post-secondary educational opportunities, and preparing them for college and adulthood. These programmatic outcomes are based on the theoretical underpinnings of the Eccles Expectancy-value model and importance of youth development skills and career preparedness skills documented in previous literature. The evaluation design is a one-group time series study examining a single cohort of girls ($n = 131$) from grades 8 through 12, with mean age = 15.41 years ($SD = 1.26$). Both qualitative and quantitative data were gathered from the participants and program staff. Survey data from program participants were gathered from the participants before the intervention (Time 1), at the end of the intensive summer workshops (Time 2) and then again at the end of the school year (Time 3). Qualitative data were gathered from focus groups of both program participants and program staff at the end of the year.

Strand 7: Pre-service Science Teacher Education

S1.11 Developing Preservice Teachers' Science Teacher Identity

1:00pm – 2:30pm, Curacao 7

Presider: April Luehmann, University of Rochester

S1.11.1 Examining the Impact of Online Blogging on Pre-service Teacher's Perceptions about their Development as Science Teachers

Ratna Narayan, Texas Tech University, ratna.narayan@ttu.edu

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Lori L. Petty, University of Texas, Brownsville
Deniz Peker, Virginia Tech
Sungwon Chung, Texas Tech University

ABSTRACT: Blogs are “personal journals made up of chronological entries, not unlike a paper diary” (Huffaker, 2005). The purpose of the study was to explore the impact of online blogs on pre-service teachers’ perceptions about their development as elementary science teachers. Eighteen elementary pre-service teachers enrolled in a science methods course were required to maintain a personal online blog throughout the semester. Password protected blogs hyperlinked to each other were set up for the instructor and participants to post reflections based on the readings and activities each week. Data collected included pre/post one-on-one audio-taped interviews with the pre-service teachers, the blog entries and focus group interviews conducted after the course. Participants expressed that the ability to examine their own practice was the most important factor contributing to their development as a science teacher. Four features of the blog were identified to aid participants developing into reflective practitioners; a) expressing themselves in their own voice, b) public nature of the blog, c) timely feedback from instructor / peers and d) multiple representations of reflections. This study has implications for both science teacher educators and science teachers.

S1.11.2 Pre-service Elementary Science Teacher Identity Development through Blogging in Communities of Practice

Janice L. Anderson, University of North Carolina at Chapel Hill, anderjl@email.unc.edu
Julie E. Justice, University of North Carolina at Chapel Hill
Steven D. Wall, University of North Carolina at Chapel Hill
Kathleen Nichols, University of North Carolina at Chapel Hill
Jennifer Jones, University of North Carolina at Chapel Hill
Helen Crompton, University of North Carolina at Chapel Hill

ABSTRACT: One of the goals of science teacher preparation is to develop professionals who are reflective of their practice and who seek collegial collaboration in order to counter perceived isolated teaching practice. This study seeks to determine the ways in which blogging, and participation in a web 2.0 community of pre-service elementary teachers, specifically, facilitated the development of teacher practice. Building upon the previous work with in-service teachers of Luehmann (2008), we examined pre-service teacher participation in an online community of practice where pre-service teachers, over the course of their elementary education program, move from being positioned as legitimate peripheral participants to fully engaged professionals (Lave & Wenger, 1991).

S1.11.3 Combining Service Learning and Action Research for Preservice Science Teacher Education: Explorations of Learning

Carolyn S. Wallace, Auburn University, csw0013@auburn.edu

ABSTRACT: In recent years, two pedagogical models known as service learning and action research have been increasingly incorporated into preservice teacher education programs. The purpose of this qualitative interpretive case study was to investigate how secondary science preservice science teachers’ ideas about learning, learners, teaching, and their own teacher identity developed during participation in an integrated service learning and action research project. Critical realist social theory (Archer 1988, 1995) was used as an epistemological tool to explore how social interactions involved in service learning were interpreted by the four case study participants and how their ideas about learning and teaching were (or were not) shaped. Results indicated that what the preservice teachers learned varied from powerful, personal and authentic understandings of concepts such as prior knowledge to deeper understandings of reflection and in one case to little growth in understanding of teaching and learning. The discussion reflects on possible mechanisms for these outcomes in the light of the participants’ biographical contexts.

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Strand 8: In-service Science Teacher Education

S1.12 Barriers to Change

1:00pm – 2:30pm, Curacao 8

Presider: Anita Martin, University of Illinois

S1.12.1 Science Teachers' Perceptions of the Barriers to Classroom Implementation of Model-based Reasoning

Patrick Dowd, University of California, Davis, pfdowd@gmail.com

Lin Xiang, University of California, Davis

Connie Hvidsten, University of California, Davis

Cynthia Passmore, University of California, Davis

ABSTRACT: The focus of this study is on investigating the barriers that science teachers face when they design and implement model-based reasoning (MBR) instruction in their classrooms. The participants were 53 classroom science teachers, participating in two, two-year cohort groups, who were involved in the Innovations in Science Instruction through Modeling program (ISIM). Qualitative data were collected through reflective writing prompts at multiple intervals throughout the professional development program. Findings reveal that science teachers encounter teacher-related, school setting, and cultural barriers to implementing MBR instruction. These barriers often interweave with each other and impact teacher's implementation of MBR. Specifically, a number of barriers emerged from the analysis that were linked to MBR instruction which included: 1) teachers saying they need time to learn their subject matter better to teach MBR effectively, 2) teachers finding it difficult to design their MBR lessons without the collaborative support of their subject area peers, some of whom were resistant to a different pedagogical approach 3) teachers finding it difficult to implement collaborative norms in their classrooms, which are essential for giving students opportunities for collective reasoning, and 4) teachers were unsure how to implement MBR within an educational culture which stresses coverage and standardized tests.

S1.12.2 Making It Work: Three Case Study Narratives from a Secondary Science Teacher Professional Development Program

James B. Cooper, Mississippi Academy for Science Teaching, Jackson State University, james.b.cooper@jsums.edu

Kristin Bass, Rockman et al.

Sarah Mushlin, Rockman et al.

ABSTRACT: This paper presentation will focus on three case studies from the evaluation of a National Science Foundation funded professional development program for high school science teachers, Southern State Academy for Science Teaching (SSAST). The case narratives will provide a detailed description of teachers' application of program content, the contextual constraints they face and the ways in which their backgrounds shape their relationships with the program. A cross-case analysis will present shared themes. It will also describe the unique ways in which each participant came into the program intending to fulfill professional goals and how each teacher's context has mitigated or enhanced her/his ability to accomplish those goals.

S1.12.3 Results of a Two-year Study: Exploring the Relationship of Teachers' Pedagogical Discontentment to Changes in Practices for 28 Rural Science and Mathematics Teachers

Margaret R. Blanchard, North Carolina State University, Meg_Blanchard@ncsu.edu

Jason W. Osborne, North Carolina State University

Jennifer L. Albert, North Carolina State University

ABSTRACT: Teachers can be resistant to reform if it requires them to shift their teaching practices substantially. This has often been explained as teachers having inadequate self-efficacy required to reform their practice. Yet recent studies describe teachers with high self-efficacy who remain resistant to change. This study explores the role of pedagogical discontentment as a possible motivator for changing teaching practice. This paper reports our quantitative findings of a two-year study. Middle school science and mathematics teachers involved in professional development were nearly eight times more likely to change toward more reform-based practices when pedagogical discontentment was higher.

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Our findings indicate that exploring pedagogical discontentment in practicing teachers may be beneficial in working toward more impact from professional development.

S1.12.4 Teachers' Perceived Challenges and Barriers to Implementing High-Level, Inquiry-Based Curriculums

Darin S. Munsell, Illinois Institute of Technology, munsdar@iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The purpose of this qualitative study is to document teachers' perceived challenges and barriers they must overcome when implementing higher-level, inquiry-based curriculums. Survey data were collected from 97 teachers from May until June of 2010. The survey population consisted of a sample of two populations of teachers. The first population of teachers (n=65) was a group of urban Midwestern teachers participating in a multi-year professional development which addressed the nature of science and scientific inquiry in their curriculums. The second group of participating teachers (n=32) was comprised of participants from across the United States in an inquiry-based lesson planning professional development at a national science teacher convention. The wealth of survey data and follow-up interviews were utilized to establish nine distinct categories of perceived challenges and barriers. Additionally, several clear trends were noted across the teacher demographics. The findings of this study offer additional areas for consideration beyond those highlighted by previous research into inquiry-based curriculum implementation. Overall, this study offers a baseline for further research to assist teachers in overcoming the many challenges and barriers that they may face when implementing inquiry-based curriculums.

Strand 10: Curriculum, Evaluation, and Assessment

S1.13 Strand Sponsored Session - Exploring Large-Scale Assessment: A Four-Nations Perspective

1:00pm – 2:30pm, Bonaire 1

Presenters:

David F. Treagust, Curtin University, d.treagust@curtin.edu.au

John O. Anderson, University of Victoria

Chorng-Jee Guo, National Changhua University of Education

Xiufeng Liu, State University of New York at Buffalo

ABSTRACT: This invited strand session will focus on large-scale assessment in science within Australia, Canada, Taiwan, and the United States. Experts in large-scale assessment from each of these countries will provide an overview of their large-scale assessment initiatives, giving educators and researchers an opportunity to compare the uses and instructional implications of each initiative. As well, secondary data analysis stemming from these initiatives may add to what is known about the impact of large-scale assessment on teaching and learning in science.

Strand 10: Curriculum, Evaluation, and Assessment

S1.14 Related Paper Set - Measuring Teacher Inquiry Knowledge

1:00pm – 2:30pm, Bonaire 6

Discussant: Jon E. Pedersen, University of Nebraska-Lincoln

ABSTRACT: Planning and implementing successful inquiry-based learning in the science classroom is a demanding task for teachers, requiring a combination of several kinds of knowledge: science content knowledge, science pedagogy knowledge, knowledge of inquiry, and knowledge of how to implement it in instruction. In order to understand how such knowledge impacts teacher instruction and their students' learning, it is important that we have valid and reliable ways to assess this construct. This panel presentation will discuss various instruments and approaches for measuring teacher inquiry. These instruments represent a variety of formats (including multiple choice assessments, Likert-type scales, and rubrics) and target audiences (pre- and in-service teachers from various grade levels and science subject areas). Data sources include written reflections, lesson narratives, group discussions, interviews, and videos of classroom practice. Panelists will discuss a) how the instruments were developed, b) how they have been used, and c) results and findings.

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S1.14.1 Development and Validation of an Instrument to Measure Teacher Knowledge of Inquiry

Gwen Nugent, University of Nebraska-Lincoln

Greg Welch, University of Nebraska-Lincoln

Jim Bovaird, University of Nebraska-Lincoln

S1.14.2 Teaching Scenarios as a Probing Tool: Teachers

Nam-Hwa Kang, Oregon State University

S1.14.3 A PCK Rubric to Measure Teachers

Julie Gess-Newsome, Northern Arizona University

April Gardner, BSCS

S1.14.4 Assessing Pedagogical Content Knowledge of Inquiry Science Instruction

Dav Schuster, Western Michigan University

William Cobern, Western Michigan University

Brooks Applegate, Western Michigan University

Strand 11: Cultural, Social, and Gender Issues

S1.15 African American Children and Science: Identity, Representation, and Implications for Science Education

1:00pm – 2:30pm, Bonaire 2

Presider: Mary Atwater, University of Georgia

S1.15.1 Young African American Children Constructing Narrative Identities in an Urban Science-Literacy Classroom

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

ABSTRACT: This study explores the ways in which the interview setting creates affordances for understanding the narrative identities constructed by young African American children who attend a high-poverty, urban school where they and their third-grade teacher attempted to enact interactive, participatory, and dialogic pedagogy in the context of integrated science-literacy instruction for one year. Using three different types of interviews of ten students in one third-grade class, I analyzed data for each student across interviews and for each interview across students to understand how young children construct student and science student identities. I found that allowing children to narrate their experiences of science inside and outside of school, listening to those narrations in the context of different types of interviews, and juxtaposing the data from various interviews yield rich portraits of children positively engaging with school and science.

S1.15.2 Curriculum as a Weapon for Combating Systemic Racism: A Description of Science Unit for Elementary African American Science Learners

Jomo W. Mutegi, Indiana University - IUPUI, jmutegi@iupui.edu

ABSTRACT: “Science for All” is a mantra that has guided science education reform and practice for the past 20 years or so. Unfortunately, after 20 years of “Science for All” guided policy, research, professional development, and curricula African Americans continue to participate in the scientific enterprise in numbers that are staggeringly low. What is more, if current reform efforts were to realize the goal of “Science for All,” it remains uncertain that African American students would be well-served. This paper challenges the idea that the type of science education advocated under the “Science for All” movement is good for African American students. It builds on the idea that African American students are uniquely situated historically and socially and would benefit greatly from a socially transformative approach to science education curricula designed to help them meet their unique sociohistorical needs. The paper describes a science curriculum for elementary African American learners that reflects the principles of a socially transformative curriculum perspective.

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S1.15.3 Identify-A-Scientist: How Third Grade African American Students See Scientists

Leon Walls, University of Vermont, lwalls@uvm.edu

ABSTRACT: Promoting science literacy is a key motivation for the science education community (Laugksch, 2000). A scientifically literate individual generally learns science better, achieves greater success on science assessments, and ultimately makes better decisions when using science in their everyday lives. Research though, has indicated that science literacy cannot be achieved without first establishing an informed understanding of the nature of science (NOS) (DeBoer, 1991; Klopfer, 1969; National Science teachers Association [NSTA], 1982). An important component of an individual's views of science is their view of scientists as well. Therefore, understanding a student's perception of scientists may be an effective and positive tool in helping achieve science literacy through instruction (Finson, 2002). With the original goal of extending the capability and reach of the DAST in its use with very young children, the Identify-A-Scientist (IAS) protocol was developed for this study. The IAS was especially relevant to the specific population of students who took part in this study. Along with the dearth of research documenting the NOS views of the very young, there is also a similar paucity of knowledge relative to children of color, specifically African Americans. Findings indicate that these third graders hold specific views of who they believe is a scientist.

S1.15.4 Young Black Children and Science: Chronotopes of Narratives around their Science Journals

Maria Varelas, University of Illinois at Chicago, mvarelas@uic.edu

Justine M. Kane, Wayne State University

Wylie Caitlin Donahue, University of Cambridge

ABSTRACT: Using Bakhtin's construct of chronotopes, we analyzed conversations with 30 Kindergarten-2nd grade African American students from three different classrooms where they were experiencing integrated science-literacy instruction, at one public elementary school in an economically-struggling, big city neighborhood. The conversations were centered on children's science journal pages that they selected as showing their best work as scientists/science students. We studied how time-space relationships played out in conceptions Black children create about who they are in relation to science and what science is as an enterprise of actors, acts, and forces. The in-depth profiles we produced demonstrate how different children intertwined conceptions of self, science, and scientists in similar, but also different, configurations. For some, words and their socio-historical meanings were markers of their relationship to science. For many, peers and/or their teacher were critical constituents of the chronotopes of their narratives. For some, their own, past initiatives had made them knowledgeable and positioned them as people who pass along science knowledge to others. Chronotopic analysis has been applied to classroom discourse, but we extend it to interactions around texts children produce to communicate ideas and their ways of making sense of these texts, thus elaborating their "becoming" vis-à-vis science and scientists.

Strand 12: Educational Technology

S1.16 Strand Sponsored Session - Digital Games and Conceptual Change in Core Concepts

1:00pm – 2:30pm, Bonaire 3

Discussant: Diane Ketelhut, Temple University

Presenters:

Douglas B. Clark, Vanderbilt University, doug.clark@vanderbilt.edu

Mario Martinez-Garza, Vanderbilt University

Jody Clarke-Midura, Harvard University

Jilliane Code, Harvard University

Brian C. Nelson, Vanderbilt University

Cynthia M. D'Angelo, University of Wisconsin

Nathan Holbert, Northwestern University

Uri Wilensky, Northwestern University

Kent J. Slack, Arizona State University

Pratim Sengupta, Vanderbilt University

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ABSTRACT: Research into the use of video games and virtual worlds for science learning is evolving rapidly, with increased focus on the need for evidence for learning, and on systematic inquiry into design principles that can best support learning and engagement. The session brings together researchers who investigate the potential of games to support and assess conceptual change. Specifically, the session explores three questions. Do data support the claim that games can effectively support valuable science learning? How can we leverage the affordances of a digital game to both support and assess deep conceptual change? What design principles can we distill from these findings in terms of supporting science learning in games and virtual worlds?

Strand 14: Environmental Education

S1.17 Strand Sponsored Session - Science Education as One Context for Education for Sustainable Development (ESD) and Environmental Education (EE)

1:00pm – 2:30pm, Bonaire 5

Presider: Teddie Mower, University of Louisville

Presenters:

Teddie Mower, University of Louisville, t0phil01@louisville.edu

David B. Zandvliet, Simon Fraser University

Annette Gough, RMIT University, Australia

Noel Gough, La Trobe University, Australia

Pauline W. U. Chinn, University of Hawaii

Justin Dillon, King's College London, United Kingdom

ABSTRACT: This invited session will explore the synergies, both current and possible, between ESD/EE and Science Education. With the increased recognition of the fragile state of our planet the international community has called for strengthening environmental literacies for all people, at all levels. This includes science as well as social, economic, and political concepts. We will review the history of the sometimes conflicted relationship of science and environmental education through the context of our Strand beginnings, share challenges and opportunities in developing synergies that improve outcomes in both fields, and discuss what makes good environmental education research at this intersection. Participants will engage in further discussion aimed at building capacity and mapping out future activities (research, policy, and education) to grow and nurture ESD and EE in the context of science education.

Strand 15: Policy

S1.18 Perspectives of Science Education Practitioners

1:00pm – 2:30pm, Antigua 2

Presider: Sarah J. Carrier, North Carolina State University

S1.18.1 Development and Initial Validation of New Science and Mathematics Faculty Measures of Change, Self-Efficacy Beliefs and Organizational Culture

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

Lisa Martin-Hansen, Georgia State University

Chad Ellett, CDE Research Associates, Inc.

Judith Monsaas, University System of Georgia

Judy Awong-Taylor, Georgia Gwinnett College

Nancy Vandergrift, University of Georgia

Chuck Kutal, University of Georgia

ABSTRACT: This paper describes the development and initial validation of new measures of faculty perceptions of change, self-efficacy beliefs, and organizational culture in institutions of higher education (IHEs) and discusses the implications of the findings for understanding change and sustainability of policy-based initiatives in IHEs. This study used a large-scale, web-based administration of three new survey measures of science and mathematics faculty

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perceptions of change, self-efficacy beliefs, and organizational culture as these pertained to a new Board of Regents policy-based initiative to improve the scholarship of teaching and learning and faculty work in K-12 schools. This paper reports useable data received from 320 faculty members (45%). A set of data analyses was performed. This included, but was not limited to, descriptive statistics for characteristics of the sample and for measurement items, a series of Principal Components Analyses on each of the three measures to empirically verify measurement dimensions, and Alpha internal consistency reliability coefficients for each measurement dimension. The results of this study show that faculty somewhat agree that there has been some recognition and reward for faculty work in schools. However, applied research in schools is not yet valued at the department level.

S1.18.2 Voices from the Front Lines: Exemplary Science Teachers on Education Reform

Burton Erin E. Peters, George Mason University, epeters1@gmu.edu

Wendy M. Frazier, George Mason University

ABSTRACT: The purpose of this study is to gain insight into the experiences that nationally award-winning, exemplary science teachers have had over their career and examine the alignment their responses with calls for K-12 science education reform from a selection of prominent commissioned government reports since 1980. From an assessment of the alignment of exemplary teachers, calls for reform have had a limited effect and highlight the weakness of using national reports as a wide-scale, nationalized approach to science education reform. Findings are focused on seven different areas of teacher development: classroom issues, teaching scientific inquiry, use of technology, pre-service experiences, professional development of in-service teachers, vertical articulation, and science education reform over time.

S1.18.3 Principals Goals for Science Education

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

Kimberly S. Lanier, The University of Miami

Sherry A. Southerland, The Florida State University

ABSTRACT: In order to achieve the vision contained in documents such as Science for All Americans and The National Science Education Standards, the conditions for change must be present within our schools. Two of these conditions for change are: (1) administrative support for this vision and (2) that the goals of the reform align with those of the actors charged with its implementation. The reform documents promote the goal of education as preparation for civic participation. This is contrasted with goals that view education as either to promote increased individual and collective economic output or upward social mobility for select individuals. Seeking to determine if goals favored by administrators aligned with the reform documents, high school principals were surveyed using a science specific survey developed along these three goals. Results indicate that all principals' believe in the first goal, with some also believing in the second goal. There are also varying degrees of belief depending on previous teaching experience: principals who taught science had more support for the first goal and less for the second two goals than their non-science teaching counterparts. We postulate this is due to a more nuanced pedagogy for those principals who had previously taught science. Implications for school administration policy are presented.

S1.18.4 Mediating Mixed Messages: An Exploratory Study of Urban Elementary Teachers' Personal Agency Beliefs in the Context of Comprehensive School Reform

Jessica Gale, Emory University, jdgale@emory.edu

ABSTRACT: Despite decades of reform, science education remains neglected in far too many of our nation's elementary schools. Because elementary teachers are ultimately responsible for implementing science reform initiatives, revitalizing science education requires understanding elementary teachers beliefs about themselves as science teachers and about their local school context. At the same time, because elementary science education reform occurs within complex educational environments comprised of multiple and often competing policies, teachers' beliefs must be considered within the context of state, district, and local school reform activities. Drawing on Ford's (1992) Motivational Systems Theory, this study explores personal agency beliefs among elementary teachers (n=109) working in one urban school district. Teachers completed an online survey comprised of three scales: the STEBI, the CBATS Enable Scale, and the

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CBATS Likelihood Scale. The study also explores variations in elementary teachers' personal agency beliefs across six comprehensive school reform models.

Administrative Symposium

S2.1 Developing High Quality Reviews for the Journal of Research in Science Teaching

2:45pm – 4:00pm, Antigua 1

Presider: Bob Geier, University of Michigan

Presenters:

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

Joseph S. Krajcik, University of Michigan

Patti Bills, Michigan State University

Hayat Hokayem, Michigan State University

ABSTRACT: The purpose of this session 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 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.

Strand 1: Science Learning, Understanding and Conceptual Change

S2.2 Argumentation and Knowledge Construction

2:45pm – 4:00pm, Curacao 1

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

S2.2.1 Science Learning and Argumentation: How are they Related?

Hanife Hakyolu, hakyoluhanif@yahoo.com

Bekiroglu Feral Ogan

ABSTRACT: Research on argumentation in science education has expanded and intensified considerably over the past two decades. Whereas there are some studies presenting the effects of argumentation on science knowledge development, there are only a few studies discovering the interrelationship between knowledge construction and argumentation. Therefore, the purpose of this study was to contribute to literature toward a better understanding of how argumentation is associated with knowledge development in science. Therefore, the following research question put a light for this study: Are there any patterns between the quantity and quality of students' arguments and their physics knowledge development through the argumentation process? Case study design was guided to the research. The participants of the study were pre-service physics teachers. Argumentations were embedded in the method class. The participants' argumentations were analyzed both quantitatively and qualitatively by relating with the students' conceptual changes. Findings demonstrate that students' conceptual levels develop positively together with their engagement and increasing quality of rebuttals during argumentations

S2.2.2 Impact on Year 4 Student Conceptual Understanding of Force and Motion after Writing Letters to Year 11 Students

Ying-Chih Chen, University of Iowa, ying-chih-chen@uiowa.edu.tw

Brian M. Hand, University of Iowa

Leah Mcdowell, Seneca Valley School District, Pittsburgh, PA

ABSTRACT: Writing-to-learn activities calling for students to write to different audiences different from teachers required them focus on translation, in which students explain, elaborate, and integrate their understanding of science

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concepts using more than just the technical language of the subject. This quasi-experimental and pre/posttest study aimed to examine if Year 4 students completed letter-writing exchange activities with Year 11 students perform better than students who do not. The participants included 835 Year 4 students and 450 Year 11 students from four elementary schools and one secondary school in the USA. The study took place within the context of a unit on force and motion that was taught for 8 weeks. Results indicated that students who engaged in doing letter-writing exchange activities outperformed students who did not by comparing pretest and posttest. The results also showed that female, special, low socio-economic status, and gifted students benefited from the letter-writing tasks more than those sub-groups in control groups. The correlation result showed that there are statistically significant correlations between student performance on tests and writing quality. Two factors of writing--cohesiveness and evidence support--were identified as potent predictors for student performance on tests.

S2.2.3 Kindergartners' Understandings about Seeds, Plants and Scientific Knowledge Building

Deborah C. Smith, The Pennsylvania State University, dcs27@psu.edu

Alicia M. Mcdyre, The Pennsylvania State University

S2.2.4 Characterizing Uncertainty Associated with Middle School Students' Scientific Arguments

Amy R. Pallant, The Concord Consortium, apallant@concord.org

Hee-Sun Lee, Tufts University

ABSTRACT: Kindergartners' understandings about seeds, plants and scientific knowledge building Abstract Our exploratory study focuses on kindergarten students engaged in a three-week unit on seeds, plants and their growth. In the classroom, teachers designed opportunities for children to engage in the four strands of scientific proficiency from Taking Science to School (Duschl, Schweingruber, and Shouse, 2007). Before and after the unit, we interviewed children about their ideas about seeds, plants and their growth, and how people make scientific knowledge. This paper presents findings from the interviews, for children's progress in understanding seeds, plants, and their growth, as well as their understanding of how scientific knowledge is constructed. We provide examples of classroom experiences that supported children's learning and participation in the four strands.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S2.3 Exploring Socio-Scientific Issues in the Science Classroom

2:45pm – 4:00pm, Curacao 2

Presider: Wesley Pitts, Lehman College

S2.3.1 What will Students Learn when Working with a Socio-Scientific Issues: Are Cell Phones Hazardous?

Britt Lindahl, britt.lindahl@hkr.se

Maria Rosberg

ABSTRACT: This paper presents results from one part of a study about lower secondary students' and teachers' experiences and learning when working with a socio-scientific issue in science education. The case: Are cell phones hazardous? started from two articles from the same newspaper – one saying that there are no risks associated with the use of cell phones and another saying that the risk for developing a brain tumour is considerable. Data was collected using observations, tape and video recording, interviews and questionnaires. Both boys and girls found this case very interesting and related to a current issue. Almost all students claim that the introduction to the case aroused their interest and that they learnt new facts during the work. The more interesting the students found the case, the more they claimed they hve learnt. We also have results indicating the importance of the teachers' way of introducing and structuring the work. Further analysis will give us more information about what is crucial and how we can improve this way of working.

S2.3.2 Students and their Parents Speak Out on the Purposes of Learning Science in Middle School

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

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Pamela Cantrell, Brigham Young University

Erin Whiting, Brigham Young University

Erika Feinauer, Brigham Young University

ABSTRACT: Scant research has focused on what students and their parents view as the purposes of science education in middle school. It is also unclear how their perceptions align with those of the science education community. This descriptive study seeks to answer these questions, using a survey research design with 7th and 8th grade students and their parents. Preliminary results from these data suggest that both students and parents view learning science as useful; they differ, however, in their views of how learning science is useful. Neither group emphasizes learning science in middle school as a means of preparing students for future schooling; nor does either group emphasize that knowing science and the way science works informs an individual's thinking about the world or as inherently interesting or enjoyable, as a way of enriching one's life. While parents and students agree that there is intrinsic value in knowing science, few participants noted that learning science leads to more informed decision-making. Briefly, these results suggest that although the participating parents' and students' perspectives about the purposes of learning science in middle school are remarkably aligned with one another, they are not aligned with the perspectives of the science education community.

S2.3.3 Evaluation of an Intervention to Improve Students' Use of Content Knowledge when Dealing with Socio-Scientific Issues

Italo Testa, Federico II University, Naples, Italy, italo@na.infn.it

Ester Salvato, Convitto Nazionale, Naples, Italy

ABSTRACT: This study investigated the effects of a four-week teaching intervention on 14-15 years old students' capability of exploiting science content knowledge in discussing Socio-Scientific Issues (SSI). The intervention addressed energy, modelling and data quality using four SSI scenarios as meaningful contexts. Students' learning outcomes were measured before and after the intervention with a multi-level assessment instrument. A delayed-post assessment was implemented three months after the end of the activities. The qualitative analysis shows that students were able to take advantage of the addressed science concepts to support in a more informed way their claims about the proposed SSI. Amongst the proposed activities, those centred on modelling and data quality were more effective than those focused on energy. The quantitative analysis indicates that students' scores in the post-test were statistically significantly different than their scores in the pre-test. The delayed-post outcomes suggest also long-term effectiveness of the intervention. The collected evidence provides support for introducing in science curricula SSI-based interventions. In addition, this study advances research in the field showing that students capability to reason and decide about SSI relying on content knowledge may be improved by means of a suitable choice of concepts addressed during the interventions.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S2.4 Related Paper Set – Talking to Learn and Learning to Talk in Secondary Science

2:45pm – 4:00pm, Bonaire 8

ABSTRACT: This set of papers reports the work of the 3 year project 'Talking to Learn, Learning to Talk in Secondary Science'. Working with 4 secondary school, science faculty, the project had two primary aims. First to see if it was possible to develop teachers use of argumentation as a pedagogic practice by establishing a professional learning community within the schools working with two instructional leaders trained by the project. Second, to see what effect the greater use of argumentation had on (a) students non-verbal reasoning and attainment in science, (b) their understanding of the nature of science, and (c) their interest and engagement with science. To answer the first goal, data were collected by extensive video observation of teachers, teacher interviews and field notes from teacher meetings. To answer the second goal a mix of quantitative and qualitative data were used. Surveys data from instruments administered to 480 6th and 8th grade students pre and post were compared with a control sample. Similarly interview of 48 student pairs, analyzed thematically, were compared with 48 from the control sample. This

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paper set will present the findings from this extensive data set, which were mixed, and discuss the implications for further research.

S2.4.1 Developing the Teaching of Argumentation in School Science Departments

Shirley S. Simon, University of London
Andri Christodoulou, King's College London
Christina Howell-Richardson, King's College London
Katherine Richardson, University of London
Jonathan F. Osborne, Stanford University

S2.4.2 Argumentation by Design: A Study of Teachers' Capacity to Enact of Argumentation Activities Beyond the Classroom

Katherine Richardson, University of London
Ruth Amos, University of London

S2.4.3 Epistemic Features of Science Teachers' Talk During Argumentation Instruction

Andri Christodoulou, King's College London
Jonathan F. Osborne, Stanford University

S2.4.4 A Study of the Effect of Engaging in Argumentation on Students' Ability to Reason, their Understanding of the Nature of Science their Engagement with School Science

Jonathan F. Osborne, Stanford University
Shirley S. Simon, University of London
Andri Christodoulou, King's College London
Christina Howell-Richardson, King's College London
Katherine Richardson, University of London

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies**S2.5 Science and Literacy**

2:45pm – 4:00pm, Curacao 3

S2.5.1 Primary Grade Children

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

ABSTRACT: This study examined the effects of Language-Enriched Science Instruction on diverse children's science vocabulary knowledge. Six second-grade classrooms participated in instruction on the Water Cycle. Three of the classrooms implemented the school district textbook instruction, while the other three classrooms implemented Language Enriched Science Instruction which included multiple multi-leveled informational trade books, hands-on activities, vocabulary activities, read-alouds, partner reading, and writing. Results suggest that Language Enriched Science Instruction was more effected in increasing children's vocabulary knowledge about the Water cycle. In addition, children who participated in Language Enriched Science Instruction wrote longer explanations of the Water Cycle, using a wider range of scientific vocabulary. Finally, type of instruction was found to be a stronger predictor of children's outcomes than was prior vocabulary knowledge, and gender was not significantly related to any outcomes.

S2.5.2 Engineering Design and Literacy in a Bilingual Elementary Classroom

Kevin Carr, Pacific University, Oregon, kcarr@pacificu.edu
Elizabeth Schlessman, Lincoln Elementary School, Woodburn, OR

ABSTRACT: How might science teaching remain a high priority in elementary classrooms, while at the same time satisfying policy demands for more time devoted to literacy development? This paper describes and interprets a short episode in which an elementary teacher and a science educator coteach an engineering design unit in a 5th grade

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bilingual classroom. We illustrate how an engineering design project provided a unique and powerful space to develop literacy, especially in speaking, writing, and listening. We hope to better understand how to equip teachers to make science a central focus of classroom learning, while acknowledging the primacy of literacy in elementary school policy discourse.

S2.5.3 Writing and Learning in Science: Connections between Elementary Teachers' Beliefs and Practice

Nicole J. Glen, Bridgewater State University, nglen@bridgew.edu

ABSTRACT: Research shows writing can help students gain conceptual understanding of both science content and the scientific discipline. Unfortunately, many science teachers rarely consider writing as a means to building students' conceptual science understanding. This qualitative case study looked at how four elementary teachers viewed the connection between writing and learning in science. The results were that the teachers believed students learned science best through "hands-on" science experiences, reading about science, and the transmission of scientific facts. These beliefs and practices were also reflected in the teachers' uses of writing in science and their understanding of how scientists used writing. Many of the teachers' science lessons involved the transmission of information, possibly resulting in why much of their students' writing was also used to transmit facts to others. In addition, the teachers' believed that scientists used writing for communicating factual information, which included not only listing scientific facts but also procedures, observations, and conclusions. The implications of this study are that teacher educators must attend to teachers' understandings about both science learning and the nature of science in order to help teachers understand how writing can be used for conceptual knowledge gains in science.

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

S2.6 Argumentation and the Nature of Science

2:45pm – 4:00pm, Curacao 4

President: Irene U. Osisioma, California State University, Dominguez Hills

S2.6.1 Traversing the Divide between High School Students and Sophisticated Nature of Science: A Multi-pronged Approach

Tami Russell, The University of Tennessee Hardin Valley Academy/High School, russellt4@k12tn.net

Mehmet Aydeniz, The University of Tennessee

ABSTRACT: This study investigated the effects of a multi-pronged approach to enhance high school students' understanding of nature of science (NOS). The intervention consisted of explicit/reflective NOS instruction embedded within authentic inquiry experiences and online discussion of various tents of NOS. Thirty one students participated in the study. NOS views were assessed using multiple data sources including pre/post-intervention questionnaires as well as student responses to online discussion prompts. Results show that the instructional intervention used in this study which combined explicit/reflective NOS instruction with intense inquiry exposure along with ample reflective opportunities in an anonymous online discussion format led to significant learning gains in students' understanding of each domain of the NOS. Implications for enhancing data collection with high school students and for promising professional development opportunities for science educators are discussed.

S2.6.2 Argumentation: Exploring Instructional Practices of Three Teachers, and their Students

Maria P. Evagorou, University of Nicosia, Cyprus, evagorou.m@unic.ac.cy

Lucy Avraamidou, University of Nicosia, Cyprus

ABSTRACT: Existing studies in argumentation provide an insight into teachers' instructional practices when teaching science as argument, but do not map those practices that lead to students' success or failures in argumentation. In this study we explore the following question: What kind of instructional practices teachers use when implementing argumentation curriculum, and what is their students' performance in argumentation? The methods of inquiry applied are associated with a case study design, with three in-service teachers and their classes studying SSI. Summarizing the findings, learning activities designed to engage students in argumentation are not a sufficient condition - teachers'

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instructional practices, and students' personal characteristics are also important; and students' performance in argumentation is related to their teacher's instructional practices, even though various other conditions might have also have had an effect on students' performance in argumentation. Implications include involving teachers in the design of the argumentation activities, and creating teacher-researcher partnerships.

S2.6.3 The Effect of Using Thought Experiments on Grade 8 Students' Physics Achievement and Views of Nature of Science

Saouma B. Boujaoude, American University of Beirut, boujaoud@aub.edu.lb

Garine Santourian, American University of Beirut

ABSTRACT: This study aimed at investigating the effect of using thought experiments (TEs) on Grade 8 students' physics achievement and understanding of selected aspects of nature of science (NOS); specifically tentativeness, subjectivity, and the role of human inference, imagination and creativity. Fifty-eight Grade 8 students taking a physics course in a Lebanese private school participated in this four-month study. The experimental and control groups were taught four topics: relativity of motion, speed, forces, and energy with one difference that the experimental group used nine pedagogical TE worksheets. These worksheets were followed by whole-group class discussions about the outcome of the TE and explicit reflective historical discussions of the target NOS aspects using the contexts of TEs. Whole-group discussions were also used with the control group while explaining the concepts addressed in the TEs without using TEs and without discussing NOS aspects. Data sources included the Physics Achievement Test, used as a post-test, to assess students' achievement, and an open-ended NOS Questionnaire and semi-structured interviews used before and after instruction. Findings indicated that using TEs significantly improved student achievement in relativity of motion and the target NOS concepts except for the subjective aspect.

S2.6.4 The Relationship between Teachers' Pedagogical Content Knowledge and Beliefs of Scientific Argumentation on Classroom Practice

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

Katherine L. McNeill, Boston College

ABSTRACT: Despite the recognition that scientific argumentation promotes formative assessment by making students' thinking and reasoning visible, the practice remains infrequent. This could be attributed, in part, to a deficiency in the necessary pedagogical content knowledge required to design, facilitate, and assess lessons that cultivate argumentation. Perhaps it is also associated with the relationship between the teachers' beliefs and their practice, which has remained largely undocumented within the scientific argumentation literature. Consequently, our research addresses the following question: What is the relationship between teachers' beliefs and pedagogical content knowledge regarding scientific argumentation and their classroom practices? Data was collected through pre- and post-surveys, three videotaped classes of their teaching followed by teacher interviews of five middle grade science teachers who participated in a series of three professional development workshops held within an urban New England school district. The findings suggest that influencing teachers' pedagogical content knowledge and beliefs on scientific argumentation through professional development can be successful in changing their practice, but each teacher's level of successful enactment is dependant on his/her initial beliefs and pedagogical content knowledge.

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

S2.7 Contexts and Factors Influencing Students' Science Attitudes, Efficacy, and Interests

2:45pm – 4:00pm, Curacao 5

President: Erika G. Offerdahl, North Dakota State University

S2.7.1 Depicting Chemistry Majors' Self-Perceptions in Learning Chemistry

Murat Kahveci, Canakkale Onsekiz Mart University, Turkey, mkahveci@gmail.com

ABSTRACT: The purpose of this study was two-fold: (1) to investigate the self-perceptions of college students whose major is in chemistry about learning chemistry by a comparative analysis with respect to varying personal characteristics

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such as gender and grade level, and (2) to provide an evidence for the reliability of the modified Fennema-Sherman mathematics attitude survey to measure students' attitudes towards learning chemistry. A modified version of Fennema-Sharman mathematics attitude scale was previously adopted and its proof of reliability was already confirmed. In this study, further implementation of the instrument over college students was pictured. Internal consistency analysis revealed the Cronbach alpha values ranging from .933 to .695, which is referred as highly reliable.

S2.7.2 Investigating College Students' Self-Efficacy, Interest, and Conceptual Change About Stars

Janelle M. Bailey, University of Nevada, Las Vegas, janelle.bailey@unlv.edu

Doug Lombardi, University of Nevada, Las Vegas

Gale M. Sinatra, University of Nevada, Las Vegas

ABSTRACT: More than 400 students in a semester long, sophomore-level, general education astronomy course responded to a survey instrument containing questions relating to their self-efficacy for and interest in learning about stars, as well as their knowledge about star properties, both pre and post instruction. A hierarchical linear regression analysis of the data showed that the students' self-efficacy prior to instruction provided a statistically significant contribution to understanding about star properties at post instruction above and beyond their background knowledge. Interest in stars at pre instruction did not provide a significant contribution to understanding post instruction. A repeated measures MANOVA and follow-up tests showed that both self-efficacy and interest increased from semester's beginning to end. Not surprisingly, initial student understanding about star properties was significantly greater for participants who had a prior astronomy course compared to those that had not, and while both groups experienced a significant increase in understanding as a result of instruction, differences in understanding were appreciably less at semester's end. With both self-efficacy and interest previously theorized to contribute to personal relevance aspect of conceptual change, this study provides empirical evidence supporting the inclusion of self-efficacy as a important contributor to deeper understanding changes in about star properties.

S2.7.3 Homework, Motivation, and Achievement in a College Genetics Course

Matthew S. Planchard, University of Southern Mississippi, matthew.planchard@eagles.usm.edu

Kristy L. Halverson, University of Southern Mississippi

Jill D. Maroo, University of Southern Mississippi

Timothy I. Mclean, University of Southern Mississippi

ABSTRACT: Homework is an integral part of a college curriculum and is often used to provide opportunities for students to interact with course material in new settings. However, little research has investigated links between student motivation, homework completion, and academic achievement at the college level. The purpose of this study was to investigate student motivation for completing homework and the effect of homework on academic achievement in an undergraduate genetics course at a large, public research university. We obtained student responses on self-perceived motivating and demotivating factors, tested various factors for an effect on homework completion, and determined homework completion's effect on academic achievement. We found that credit value, self-perceived conscientiousness and attitude, and self-reported learning style had a significant effect on if students completed homework assignments for the course, and homework completion had a significant impact on students' academic achievement. Thus, instructors can use these motivating factors to design assignments in manners that encourage completion and in turn can help increase overall academic achievement.

S2.7.4 Characterizing Self-Efficacy Opportunities in the Process of Modeling a Physical Phenomenon: A Study of Three Female Modeling Instruction Students

Vashti Sawtelle, Florida International University, vashti.sawtelle@gmail.com

Eric Brewe, Florida International University

Renee Michelle Goertzen, Florida International University, Department of Physics

Laird H. Kramer, Florida International University, Department of Physics

ABSTRACT: Self-efficacy has been strongly linked to persistence in various technical fields. We present the analysis of a qualitative investigation of three Modeling Instruction women during the process of modeling a physical phenomenon

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as a discussion of self-efficacy experience opportunities (SEOs) that can be characterized during this process. At this large research institution, Modeling Instruction has been shown to positively impact student self-efficacy. This paper presents a focus on one of the key elements of Modeling Instruction, modeling physical phenomena, and characterizes the SEOs that are present during the process of modeling a particular phenomenon. We characterize these SEOs and connect them to the modeling process. Further, we find that these SEOs are abundant during the process of modeling phenomena, and thus may be partially responsible for the positive impacts on self-efficacy we find in the Modeling Instruction environment.

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

S2.8 Epistemologies of Students and Teachers

2:45pm – 4:00pm, Bonaire 7

Presider: Linda Keen-Rocha, University of Witwatersrand

S2.8.1 Collegiate Students' Epistemologies of the Role of Models in Precalculus Mathematics

Robert Melendy, George Fox University, rmelendy@georgefox.edu

Lawrence Flcik, Oregon State University

ABSTRACT: Students' epistemological beliefs of mathematical models and the role they played in describing physical phenomena was established using a modified version of Students' Understanding of Models in Science (SUMS). The modified version contained additional items that were developed to capture students' mathematical epistemologies. These new items were written into the SUMS existing subscales. The treatment group consisted of 13 males and 16 females; the control group consisted of 16 males and 13 females all enrolled in pre-calculus mathematics at two Pacific Northwest colleges. The treatment consisted of a three-part survey and follow-up interview and tutorial. A substantial number of the students in our investigation revealed a lack of coherence between the mathematical meaning of certain mathematical functions and how these functions get utilized in modeling physical situations. What is more, we discovered that a relationship existed between this lack of coherence and the epistemological beliefs that the students hold about this knowledge. We speculated that possession of such beliefs influenced students' thinking and reasoning as they attempted problem-solving activities that involved the mathematical modeling of physical situations. An interview-tutorial revealed changes in epistemological positions as measured by a modified SUMS post-test. We discuss implications for teaching and future research.

S2.8.2 Relationships Between Students' Epistemology, Argumentation, and Conceptual Understanding in Biotechnology: A Case Study

Carina M. Rebello, University of Missouri, cp5xc@mail.mizzou.edu

Stephen B. Witzig, University of Missouri

Kemal Izci, University of Missouri

Marcelle A. Siegel, University of Missouri

Sharyn K. Freyermuth, University of Missouri

ABSTRACT: Students' epistemological beliefs can influence their ability to reason, evaluate information, and make informed decisions. These skills are important for an informed citizenry that will participate in debates regarding areas such as biotechnology. We report on an in-depth case study analysis of nine undergraduate, science and non-science majors in an introductory biotechnology course. Data from multiple sources – interviews, exams, embedded assessments and a pre-post biotechnology knowledge instrument – were used to inform this study. Our findings are organized within individual profiles and a cross-case analysis to demonstrate our participants' conceptual understanding, epistemological beliefs, and argumentation quality. Overall, we found that a student with more sophisticated epistemology demonstrated a superior argumentation quality and a greater conceptual understanding of biotechnology-related topics. Results suggest the need for instructional interventions fostering epistemological development of learners in order to facilitate their conceptual growth. In conjunction with heightening students' epistemological developments, students should be provided opportunities to practice developing their skills of reasoned argumentation.

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S2.8.3 Epistemological Beliefs & Teaching Practices of Science Faculty with Education Specialties

Tracie M. Addy, North Carolina State University, tmaddy@ncsu.edu

Patricia E. Simmons, North Carolina State University

Grant E. Gardner, North Carolina State University

Jennifer L. Albert, North Carolina State University

ABSTRACT: This study investigated the teaching beliefs and classroom behaviors of science faculty with educational specialties (SFES) and their roles within the larger context of science education reform efforts, on the premises that: teaching scholarship is an area in need of reform, interdisciplinary positions (such as SFES) may encourage reform efforts, and understanding the teaching beliefs and practices that SFES hold and demonstrate provides insight into whether these faculty can improve student learning within the sciences and enact reform recommendations. The research questions guiding this study were: (1) What epistemological belief systems do SFES espouse concerning the teaching and learning of science? (2) What are the classroom practices of SFES? How are these practices congruent with reform described by the National Research Council? A case-study research design with mixed approaches was employed. Data on the epistemological beliefs, self-reported teaching approaches, and classroom teaching practices of 25 SFES from 12 U.S. public and land-grant universities were gathered and triangulated. Preliminary analyses support SFES as espousing transitional to reform-minded beliefs about teaching, self-reporting more student-centered teaching approaches, and having intermediary reformed practices. These results may provide recommendations to leaders about how SFES can influence the vision and teaching culture of their science departments.

S2.8.4 Evolution Acceptance and Epistemological Views of College Biology Students

Lisa A. Donnelly, Kent State University, ldonnell@kent.edu

Elizabeth Shevock, Kent State University

ABSTRACT: Evolutionary theory is central to biology, and scientifically-accurate evolution instruction is promoted within national and state standards documents. Previous literature has identified students' epistemological views as potential predictors of evolution acceptance. The present work seeks to more directly explore how student views of evolution are related to their epistemological views. We hypothesize that evolution acceptance may be related to students' epistemological views and that this relationship may vary depending on students' relationship to the field of biology, either as an experienced major, a new major, or a non-major. Specifically, this manuscript investigates how college students' evolution acceptance may be related to Perry developmental levels for three distinct groups of students: upper-level majors, first-year majors, and non-majors. A mixed methods approach entailing quantitative surveys and individual interviews was employed. In total 395 college level biology students from three classes were surveyed, and 44 students were interviewed. Statistical analyses revealed significant evolution acceptance differences according to both main factors, Perry Level and Class. Potential implications for science educators at the college level are discussed.

Strand 6: Science Learning in Informal Contexts

S2.9 Strand Sponsored Symposium-Learning Technologies in Informal Contexts

2:45pm – 4:00pm, Curacao 6

Presider: Sandra T. Martell, University of Wisconsin-Milwaukee

Discussant: Reed Stevens, Northwestern University

Presenters:

Mark Chen, University of Washington

Alex Games, Michigan State University

Douglas B. Clark, Vanderbilt University

Alex Games, Michigan State University

Robb Lindgren, University of Central Florida

Debora B. Wisneski, University of Wisconsin-Milwaukee

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Heather T. Zimmerman, Penn State University
Susan M. Land, Penn State University
Strulle Arlene De, National Science Foundation

ABSTRACT: A recent presidential call for greater nationwide focus on STEM education resulted in the development of educational initiatives focused on computer and video game creation. But, what do we know about how video games, mobile device applications, and other tools can support informal science learning across settings and contexts? How can informal institutions use learning technologies to support science teaching and learning among diverse learners? Collectively, this interactive symposium's panelists will discuss how traditional and contemporary games and tools help scaffold learning, distribute knowledge and expertise, provide opportunities for interactions and reflection across settings, and aid facilitation of science instruction. Researchers and scholars from informal science institutions, universities, and NSF, will present theoretical and empirical work addressing the role of learning technologies in informal science education as well as future directions for funding and research, including a protein-folding game, a conceptually-integrated physics game, a project-based curriculum centered on game design, a mixed reality game, forms of play critical for early learning, and mobile device applications. The symposium includes a brief introduction by the presider followed by panelist presentations, small group discussions, an open conversation around common themes and interests, and an expert discussant providing feedback on the panel and conversation.

Strand 7: Pre-service Science Teacher Education

S2.10 Learning Science Teaching Practices

2:45pm – 4:00pm, Curacao 7

Presider: Jennifer Cartier, University of Pittsburgh

S2.10.1 Learning to Assess: Preservice Science Teachers' Learning about Classroom Assessment

Nam-Hwa Kang, Oregon State University, kangn@science.oregonstate.edu

ABSTRACT: The study explored the degree to which a cohort of preservice science teachers developed competence in classroom assessment in terms of assessment design, analysis, and drawing implications for teaching. Assessment design and analyses of 12 preservice science teachers were examined. The findings showed a critical role of underlying beliefs about the curricula goals and learning in the PSTs' learning about assessment. The areas of emphasis in developing classroom assessment capacity included support for broadening assessment objectives and diversifying assessment methods accordingly. Implications included more emphasis on integrating informal with formal assessments and further support in adopting more innovative but practical approaches through careful field placements and close collaboration with the cooperating teacher and practicum advisors.

S2.10.2 Beginning Teachers' Development of Classroom Practice and Their Narratives of Practices toward Reform-Oriented Instruction

Hosun Kang, Michigan State University, kanghosu@msu.edu

Charles W. Anderson, Michigan State University

ABSTRACT: Designing and enacting classroom activities is a key practice for all science teachers. This study explored how beginning teachers develop this classroom practice during teacher education. Twelve secondary science teacher candidates at a five-year reform-oriented teacher preparation program participated in this study over three years. Data include: a) candidates' self-made teaching videos, b) written artifacts, and c) interviews with candidates, their mentor teachers, and course instructors. During individual interviews, we showed the same segments of candidates' teaching videos to each of them and had them talked about the specific practices that we focused on. We found three patterns in the ways of representing science through activities in candidates' teaching videos: representing science as (a) 'master narratives' or 'correct answers'; (b) skills to solve problems; or (c) tools for making sense of the world. There were some meaningful variations in the narratives of practice among candidates, mentor teachers, and course instructors. Candidates who showed similar patterns of highlighting and coding about the goals and strategies of activities to course

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instructors tended to provide students meaningful opportunities of engaging in science by representing science as 'tools.' The implications for teacher learning and research of teacher education are discussed.

S2.10.3 The Influence of Curriculum-Independent Factors on Preservice Elementary Teachers' Adaptation of Science Curriculum Materials

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

ABSTRACT: Multiple methods are employed to investigate factors influencing preservice elementary teachers' adaptation of science curriculum materials to better support students' engagement in science as inquiry. The study focuses on data collected around two 'reflective teaching assignments' completed by 46 preservice elementary teachers in an undergraduate elementary science methods course in which they were asked to use and adapt existing science curriculum materials to plan and enact inquiry-based science lessons in elementary classrooms. Data analysis involved regression modeling of artifacts associated with these lessons, as well as in-depth, semester-long case studies of six of these preservice teachers. Results suggest that while the types and inquiry scores of existing curriculum materials have a small influence on preservice elementary teachers' curricular adaptations, teacher-specific variables account for a much greater percentage of the variance. Evidence from the case studies illustrates the important influences of the preservice teachers' field placements as an explanatory, teacher-specific factor in their curricular adaptations. 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 programmatic features of teacher education programs impact their ability to do so.

S2.10.4 Elementary Preservice Teachers' Knowledge and Application of Science Vocabulary

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

ABSTRACT: Science vocabulary knowledge plays a role in understanding science concepts, and science knowledge is measured in part by correct use of science vocabulary (Lee, Fradd, & Sutman, 1995). Elementary school students have growing vocabularies and many are learning English as a secondary language or depend on schools to learn academic English. Acknowledging that the language of science poses unique challenges to students, teachers must possess knowledge of science vocabulary in order to communicate and evaluate students' science understandings. The present study examined change in preservice teachers' vocabulary knowledge during a science methods course, measuring pre- and posttests of common elementary science vocabulary. Additionally, researchers documented preservice teachers' use of science vocabulary during peer teaching. The data indicate that the course positively impacted the preservice teachers' knowledge of target elementary science vocabulary definitions; however, their use of science terms was inconsistent in microteaching lessons. Recommendations include providing multiple content area vocabulary instruction strategies during teacher preparation.

Strand 8: In-service Science Teacher Education**S2.11 Case Studies of Teacher Growth**

2:45pm – 4:00pm, Curacao 8

Presider: Martina Nieswandt, Illinois Institute of Technology

S2.11.1 Hiking Mt. Kilimanjaro: Personal and Professional Impacts on Female Elementary Teachers' Lives and Practice

Megan E. Mistler-Jackson, University of Colorado Denver, meganmj@comcast.net

ABSTRACT: In addition to continued improvement in the quality of science learning among our nation's youth, one goal of science education research is to promote wider interest in science, technology, engineering and math (STEM) disciplines. This research explores the impacts of experiential professional development for teachers and its potential to inspire interest and motivation in science education. Specifically, this study examines the participation of three female elementary teachers in a summer 2009 experiential learning course trekking Mount Kilimanjaro, going on safari in the Serengeti, and sharing their experience in a movie documentary with regard to how the experience informs their personal and professional identities and practice in their classrooms. Qualitative data such as observations, interviews and document review are analyzed. Participants report that the success of climbing Mt. Kilimanjaro is a significant

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lifetime event. The power of this experience translates into an enthusiasm in their personal and professional lives that affects their science teaching and potential to serve as positive role models for their students.

S2.11.2 Examining Real-world IT-immersion Teacher Education Experiences through the Lens of Two Teacher Roles

Cathlyn D. Styliniski, University of Maryland, cstyliniski@umces.edu

Caroline Parker, Educational Development Center

Carla Mcauliffe, TERC

ABSTRACT: The practice of providing curricular materials versus helping teachers develop their own materials is used in many professional development efforts, and use of these two roles may help us better understand how to effectively support teachers integrating real-world technology applications into their classroom. The first phase of our exploratory study examines these roles using surveys and follow-up interviews with principal investigators (PIs) of NSF-funded ITEST projects--technology-immersion teacher education experiences that share a common design implemented in unique ways. We found PIs did identify with one or the other of these two roles (adopter/adaptor versus developer), however there was no significant correlation between these roles and other surveyed items, and there was no significant grouping of these other surveyed items that distinguished the two roles. Instead, our results suggest that these roles should be considered as a continuum and together with other emerging project approaches (e.g., focus on collaboration, alignment with authentic STEM practices, connections to local environment/social context) and PIs' perspectives on teachers' expertise. In the next phase, we will continue to explore emerging approaches and perspectives of these professional development experiences and will determine if and how they influence teachers' implementation of real-world technology applications into their classrooms.

S2.11.3 Enhancing Teacher Knowledge and Pedagogical Reasoning: A Case Study of Cooperating Science Teacher Mentors

Shelly Rodriguez, The University of Texas at Austin, shelly.rodriguez@austin.utexas.edu

Julie Gess-Newsome, Northern Arizona University

James Barufaldi, The University of Texas at Austin

ABSTRACT: This study investigated what inservice science teachers who serve as mentors learn through interactions with preservice teachers in their classrooms. This study interviewed six secondary science teachers that served as cooperating teachers for a nationally recognized STEM teacher preparation program. Specifically, the study asked: How does the teaching knowledge of cooperating science teachers develop as they work with teacher candidates in a secondary science teacher preparation program? Interactions with preservice teachers were shown to expand the knowledge base of cooperating science teachers and to stimulate their pedagogical reasoning. These findings will be useful for inservice science teachers, secondary school administrators, science teacher educators, researchers in the field of science education, and others interested in the ongoing development of the knowledge base of inservice science teachers.

Strand 8: In-service Science Teacher Education

S2.12 Related Paper Set - Impact of the Communication in English and Science Inquiry Project on Teachers and Students

2:45pm – 4:00pm, Antigua 1

ABSTRACT: The findings of these four papers indicated that two years of teacher professional development in the Communication in English and Science Inquiry Project (CESIP) can have a statistically significant pre to post impact on students' ability to write scientific explanations and have an effect on their grades. The improvement in writing scientific explanations was influenced by the type of instructional activity that provided a platform for writing. Professional development had a differential impact with English teachers starting with higher implementation scores than science teachers and maintaining their scores over time while science teachers experienced a slight decline. Despite the higher implementation scores of the English teachers, statistical analysis indicated that their students did not write better scientific explanations than students of science teachers. However, the students of both the English and science

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teachers in the professional development wrote better scientific explanations than the students of a control science teacher. These findings are based upon the analysis of 1,547 student explanations and 241 classroom observations of 38 teachers.

S2.12.1 Improving Student Scientific Explanation Skills Through Research-based Professional Development

Nievita Bueno Watts, Arizona State University, nbueno@asu.edu

Dale R. Baker, Arizona State University

Gita Perkins, Arizona State University

Tapati Sen, Arizona State University

Dola Chaudhuri, Arizona State University

Michael G. Lang, Maricopa Community College

S2.12.2 Change in Implementation Practices of English and Science Teachers over Time

Tapati Sen, Arizona State University

Dale R. Baker, Arizona State University

Nievita Bueno Watts, Arizona State University

Gita Perkins, Arizona State University

Michael G. Lang, Maricopa Community College

S2.12.3 Scientific Explanations of Communication in English and Science Inquiry Project Students: Science vs English Comparison

Gita Perkins, Arizona State University

Dale R. Baker, Arizona State University

Tapati Sen, Arizona State University

Michael G. Lang, Maricopa Community College

Nievita Bueno Watts, Arizona State University

S2.12.4 The Relationship of Teacher Implementation of Professional Development to Student Scientific Explanations and Grades

Dale R. Baker, Arizona State University

Nievita Bueno Watts, Arizona State University

Tapati Sen, Arizona State University

Gita Perkins, Arizona State University

Dola Chaudhuri, Arizona State University

Michael G. Lang, Maricopa Community College

Strand 10: Curriculum, Evaluation, and Assessment

S2.13 Assessment in Chemistry

2:45pm – 4:00pm, Bonaire 1

Presenter: Yilmaz Kara, Karadeniz Technical University

S2.13.1 Evaluation of the National Educational Standards in Chemistry Education

Maik Walpuski, University of Osnabrueck Chemistry Education, maik.walpuski@uos.de

ABSTRACT: International large-scale assessments such as TIMSS and PISA have shown that the German students only rank in the medium area which is rather unsatisfactory for German politicians, teachers and researchers. As a result, the Assembly of German Ministers of Education agreed on National Educational Standards (NES) which define competences for the graduation from middle school after grade 9 or 10. Tests for all areas of competence defined by the NES are currently being developed and proved in the German project ESNas (Evaluation of the National Educational Standards

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for Natural Sciences at the Lower Secondary Level) by teachers and researchers. For the project an empirically evaluated model of competence is used in order to be able to construct test items of an a priori defined difficulty. For the subject chemistry teachers from different federal states developed approximately 150 items per area of competence (4) based on the model. A pilot study was performed in 2009/10 with approximately 250 students per item. In this presentation the underlying model of competence, the process of item development and results from the pilot study will be presented.

S2.13.2 Identifying Chemistry Laboratory Safety Conceptions

Wendy E. Schatzberg, Western Washington University, wendy.schatzberg@gmail.com

Baohui Zhang, Nanyang Institute for Education, Singapore

ABSTRACT: Students learning about new concepts incorporate new theories into their already formed mental model and misconceptions may then be created that can later become hazardous to the student. This study proposed to discover what misconceptions students were creating in relation to laboratory safety theory using the Laboratory Safety Questionnaire. This Questionnaire was created to aid in identifying common student misconceptions and assist in the creation of future intervention procedures to eliminate the possible hazardous alternate conceptions. Secondary and Junior College students in Singapore were solicited for this study and it was discovered that overall students held a good grasp of some conceptions such as safety equipment but had misconceptions about chemical qualities such as acids, bases, and safety terminology.

S2.13.3 Analysis of Teachers' Views on the Nature of Models in the Development of a New Model-based Course

Hui-Jung Chen, National Taiwan Normal University, Taiwan, karen3117tw@gmail.com

Mei-Hung Chiu, National Taiwan Normal University, Taiwan

ABSTRACT: This study investigates how five experienced chemistry teachers changed their views on the nature of models in developing a new model-based chemistry laboratory course in a senior high school in Taiwan. In order to develop the course, the teachers participated in workshops and group discussion meetings. They reported the progress of the curriculum development, reflected on teaching experiences and discussed their findings in the meetings biweekly. Data collections include questionnaires, semi-structured interviews and classroom observations for three years. Results revealed a positive impact on their comprehension of the nature of models. The average scores of questionnaires in 3rd year were significantly higher than those in 1st year and 2nd year. It also showed that the five teachers' views of the nature of models gradually reached consensus. Four of the five teachers originally considered models as representations of scientific theories. After participating workshops and group discussions, three of them shifted to mixed types of perceptions with scientific concepts and mental images after three years. This study showed that professional development for understanding models is important in developing a better model-based course. The analysis of teachers' views helps us understand the complex relationship between teachers' understanding of models and their classroom practices.

S2.13.4 Does Question Type, Content and Gender Influence Student Understanding as Demonstrated in an Entrance Examination?

Ross D. Hudson, Australian Council for Educational Research Curtin University of Technology, hudson@acer.edu.au

David F. Treagust, Curtin University of Technology

ABSTRACT: The research inquires into the effectiveness of the two predominant forms of questions that are used on the State University Entrance examination for chemistry. These are multiple-choice questions and short-answer questions. This research examines the style of question but also the content type examined (recall and application questions) along with gender differences. The research involved an analysis of previous State University Examinations as well as class trial testing students of both genders on tests designed by the researcher. Rasch analysis of the class trial data was performed allowing comparison of question type and content performance as well as differential analysis (DIF) comparing the male and female performance on different subsets of question types. Analyses of released data from the final examinations were used to provide a comparative context to the trial tests.

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Strand 10: Curriculum, Evaluation, and Assessment

S2.14 Symposium – Computer Model-Based Assessment of Learning Progression: Promises and Issues

2:45pm – 4:00pm, Bonaire 6

Presider: Xiufeng Liu, University at Buffalo, SUNY

Discussant: Erica Smith, University at Buffalo, SUNY

Presenters:

Noemi Waight, University at Buffalo, SUNY

Roberto Gregorius, Canisius College

Kristina Gillmeister, University at Buffalo, SUNY

ABSTRACT: Normal 0 false false false EN-US X-NONE X-NONE MicrosoftInternetExplorer4 This symposium session presents preliminary findings of developing computer model-based assessment of learning progression. Computer modeling is based on flash and NetLogo environments to make simultaneously available three levels of representations in chemistry: macroscopic, submicroscopic, and symbolic. Students interact with computer models to answer assessment questions. Student responses provide an indication of their levels of understanding of three big ideas in chemistry: Matter, energy, and models. The preliminary quantitative and qualitative findings suggest both promises and challenges for computer model-based assessment of learning progression. Specifically, although computer models are appealing to students, questions based on computer models do not necessarily produce consistent indications of student levels of conceptual progression. On the other hand, the better consistency and item choice structures for some items and constructs indicate a potential for computer model-based assessments of learning progression. There are both advantages and disadvantages of the question format, i.e. Ordered-Multiple-Choice, adopted in this study. Preliminary findings from this study also suggest specific areas of improvement in computer models and assessment questions. The need for integrating computer models and assessment into ongoing instruction during a chemistry course is also discussed.

Strand 11: Cultural, Social, and Gender Issues

S2.15 College Science Students: Attitudes, Beliefs, and Aspirations Related to Gender, Religion, Class and Ethnicity

2:45pm – 4:00pm, Bonaire 2

Presider: Janell N. Catlin, Teachers College, Columbia University

S2.15.1 Understanding Disadvantage: Comparing Motivation, Family Support, Preparation, and Income Characteristics of Minority and Non-Minority College Calculus Students

Charity N. Watson, Clemson University, charitw@clemson.edu

Philip M. Sadler, Harvard-Smithsonian Center for Astrophysics

Gerhard Sonnert, Harvard-Smithsonian Center for Astrophysics

ABSTRACT: When groups of students with similar academic backgrounds are compared, findings indicate that students from families with high socioeconomic status outperform students from low-SES families and Asian and White students have higher achievement than do Black or Hispanic students. The disturbingly low rates of math achievement by students of color (African-American, Latinos, and American Indian) and low-income students have gained increasing attention in the education community. Of course, no single explanation is sufficient to account for these observed average differences in achievement. Minority students are underrepresented among those obtaining degrees in STEM fields. It is argued that calculus provides the foundation for understanding higher-level STEM courses; successful completion of calculus is required for success in STEM majors. In a survey conducted by Uri Treisman (1992), it was found that there are four widely held beliefs about the causes of minority student failure in college calculus. The responses indicated that motivation, preparation, family background/support, and income, mainly the lack thereof, are the dominant factors which contribute to the failure of minority students in calculus. In this paper, the responses to key variables focusing on these four beliefs are compared for minority and non-minority students enrolled in college calculus courses.

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S2.15.2 Stories of Persistence: How Class Shapes the Experiences of Female First-generation Students in Undergraduate Science

Rachel E. Wilson, The University of Georgia, rewilson@uga.edu

Julie M. Kittleson, The University of Georgia

ABSTRACT: Class has been under-theorized in science education research. There is a need to understand how class influences students' science-related career choices, especially those populations who are underrepresented in science: women and minorities. First-generation students, or students whose parents do not have a college education, are not only less likely to persist in college, they are also more likely to be non-White, female, and from low-income families (Choy, 2001). Therefore, there is a need for research on the experiences of female students in undergraduate science programs and how their experiences are shaped by gender, race/ethnicity, and class in order to understand how these factors can shape their science-related career aspirations. As part of a qualitative research study, eleven female first-generation college students pursuing science majors were interviewed about their experiences in science. The research questions addressed how female first-generation students describe their experiences as college science majors and how their interpretations of their experiences shape their identities and their persistence. Tensions that these students felt surrounding pursuing their science-related career goals are discussed. Implications of this study include the need for class to be included as a factor of analysis in addition to race and gender.

S2.15.3 Creationism, Worldviews, and Existential Anxiety: An Ethnographic Perspective

David E. Long, Valdosta State University, delong@valdosta.edu

ABSTRACT: This paper examines college student understanding and attitudes toward biological evolution. In ethnographic work, I followed a cohort of 31 students through their required introductory biology class. In interviews, students discuss their life history with the concept - in school, at home, at church, and in their communities. For some Creationist students, confronting evolution in class has meant confronting existential issues regarding both the basis of science and the basis of faith. For other Creationist students, claims of evolution's theoretical strength are eschewed for its direct challenge to their worldview. For most students, science holds minimal interest against other values in their lives. Faculty and policy makers decry this as poor American science literacy which demands change. This work discusses the gap in socio-cultural practices between "ideal science literacy", and the everyday practical knowledge which result in half of Americans rejecting evolution as sound science.

S2.15.4 What Type of Science Person are You? Gender & Race/Ethnicity Comparisons

Zahra Hazari, Clemson University, zahra@clemson.edu

Philip M. Sadler, Harvard Smithsonian Center for Astrophysics

Gerhard Sonnert, Harvard Smithsonian Center for Astrophysics

ABSTRACT: This study explores students' self-perceptions across science subjects (biology, chemistry, and physics) by gender and under-represented minority status. The data is drawn from the Persistence Research in Science & Engineering (PRiSE) project, which surveyed 7505 college English students from 40 US colleges and universities across the nation about their backgrounds, high school science experiences, and science attitudes. We compared the responses to three focal items on the PRiSE survey which asked students: Do you see yourself as a biology/chemistry/physics person? The results indicate that students' overall self-perceptions towards science are less than ideal. For most students in college, even those pursuing science-related careers, averages fell well below the midpoint of the scale. Consistent with other research, females had significantly lower self-perceptions towards physics and females from under-represented minority groups, particularly Hispanic females, tended to be the most disempowered in their views of themselves with respect to science.

Strand 12: Educational Technology

S2.16 Dynamics of Supporting Learning Through Technologies

2:45pm – 4:00pm, Bonaire 3

President: Taha Mzoughi, Kennesaw State University

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S2.16.1 Learning and Social Dynamics in a Student Directed High School Virtual Reality Class

Teresa Morales, Iowa State University, tmorales@iastate.edu

Eunjin Bang, Iowa State University

Thomas Andre, Iowa State University

ABSTRACT: This paper reports a qualitative case history analysis of a unique, high school, student-directed, project-based learning (PBL) virtual reality (VR) class. The class was unique because it had no teacher; students were expected to learn independently to program an industrial level VR machine to create projects of their own choosing. Students were accountable for producing two projects each school quarter. The class is apparently successful, attracting interest from education and industry official and being emulated in other school districts. This study used in-depth classroom observations, interviews with selected students, analysis of student projects, and surveys of parents to examine student learning and the ongoing dynamics of the class. Three themes of classroom social traditions emerged from the analysis observations: 1) play in service of learning, 2) peer mentoring, and 3) collaborative problem solving. These traditions supported individual student learning in the learning community of the class. Student projects demonstrated that they mastered significant academic concepts and advanced technical skills. The full paper provides in-depth examples of the three themes and of student learning of academic concepts. The results were consistent with theories underlying project-based learning, but demonstrated that PBL can be effective even when not teacher directed.

S2.16.2 Relationship between Students' and Teacher's Questions in an Online Forum

Seng-Chee Tan, National Institute of Education, Nanyang Technological University, Singapore, sengchee.tan@nie.edu.sg

Lay-Hoon Seah, University of Melbourne

ABSTRACT: Situated within the context of science learning through a social collaborative inquiry approach called Knowledge Building, this study focused on the use of questions as a discourse move. The participants consisted of a 4th Grade teacher and his two elementary classes that consisted of 40 and 39 pupils respectively. Over a period of three months, the teacher created three forums with different primary tasks related to the topic Digestive System. The students were actively engaged in raising questions and seeking for answers through the use of Knowledge Forum, an online forum, both within and out of formal curriculum time. The analysis was carried out using the Ideational Function of Questions (IFQ) framework that the authors developed, which classified questions into three categories: conceptual, epistemological, and meta-discoursal questions. There were 25 sub-categories of questions. Our analyses showed that the nature of the task set by a teacher in an online forum could be one possible factor that leads to different questioning behaviors among the students. The findings shed some lights on the types of questions or tasks teachers could set in an online forum to achieve the questioning behaviors they hope to see in their students.

S2.16.3 Nature of Community in a Science Teachers' Virtual Community from a Community of Practice Perspective

Heather M. Worsham, University of Missouri, hmw7a5@mizzou.edu

Aaron J. Sickel, University of Missouri

ABSTRACT: This qualitative research study investigated the nature of community in an online community of science teachers—specifically, those participating in the National Science Teachers Association's (NSTA) list servers—using communities of practice (Wenger, et al., 2002) as a theoretical lens. An analysis of over 5,300 email communications sent via the list servers during a five month period from December 2009 to May 2010 was conducted. Findings indicated that a complex and vibrant community of practice exists within the list server groups wherein teachers of science and others interested in science education collaborate, problem-solve, and generate new ideas to facilitate meaningful science learning for students. Factors which contributed to the success of the community were revealed which might be useful for nurturing the development of other online science teacher communities. The study also gives a glimpse into what exemplary science teachers from across the country and around the world value and the discussions they are having with each other. The findings of this study would be of interest to pre-service and in-service instructors, as well as to practitioners or anyone responsible for creating or maintaining a science-teacher community.

S2.16.4 Using Web 2.0 Tools to Support Student Construction of Scientific Arguments

Jennifer L. Weible, Penn State University, jweible@gmail.com

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ABSTRACT: Web 2.0 technologies are used to support the development of science content and evidence-supported argumentation construction in high school chemistry classes. I analyze video-podcasts, delicious.com tags and resources, individual essays, and questionnaires of learners (n=71) as they participated in a unit on alternative energy resources. The technology was used to support learners as they constructed science knowledge and scientific arguments using research that was collected in groups. The goal was to study how technology can support student content learning and guide evidence-based construction of arguments as groups and individuals.

Strand 13: History, Philosophy, and Sociology of Science

S2.17 Presidential Invited Session - Inquiry, Science Practices, and the Nature of Science

2:45pm – 4:00pm, Bonaire 4

Presider: Richard Duschl, Penn State University

Discussant: Gregory J. Kelly, Penn State University

Presenters:

Agustín Adúriz-Bravo, Universidad de Buenos Aires

Douglas Allchin, University of Minnesota

Barbara A. Crawford, Cornell University

Sibel Erduran, University of Bristol

Richard Grandy, Rice University

Renee Schwartz, Western Michigan University

ABSTRACT: This Presidential session will explore issues of philosophical and pedagogical practices related to framing scientific inquiry and the nature of science as linked or unlinked. Panelists will examine topics across several domains of science education: 1) the assessment of students understanding(s) of the nature of science, 2) the design and sequencing of curriculum, instruction and assessment that attends to Strand 3 of the Taking Science to School report "Students who understand science, understand the nature and development of scientific knowledge"; 3) the current developments regarding Core Science Standards with an emphasis on Cross-cutting concepts and Science Practices and 4) the competing images of epistemology for framing NOS in science education, cognitive science and science studies. Panelists and the discussant represent diverse perspectives and scholarly domains within HPSSST (History, Philosophy & Sociology of Science and Science Teaching). Co-Sponsored with Strand 13 History, Philosophy and Sociology of Science

Strand 14: Environmental Education

S2.18 Environmental Education in Practice

2:45pm – 4:00pm, Bonaire 5

Presider: Kim Sadler, Middle Tennessee State University

S2.18.1 Exploring Environmental Education in Schools

Xavier E. Fazio, Brock University, xavier.fazio@brocku.ca

Douglas D. Karrow, Brock University

ABSTRACT: The purpose of this study is to explore environmental education (EE) practices within elementary and secondary schools. Although some EE researchers have examined particular aspects of environmental literacy as practiced in schools, there still is a scarcity of research on the detailed nature of these school-based practices. Using complementary mixed-methods (survey and focus groups) we detail these practices in schools (n=97) found within one school district. Our findings are categorized according to the following themes: (a) school settings; (b) teaching and academic background; (c) characterization of environmental literacy; (d) description of current EE practices at the school; (e) capability in implementing EE; (f) resources used in EE programs. Our overall findings indicate that elementary schools tend to approach EE using whole-school approaches when compared to secondary schools; and, those teachers with some formal teaching and academic experience with ecology or outdoor education were the de facto leaders in their school for EE programming. Furthermore, curriculum standards and school-level administration

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were considered obstacles to sustaining EE programs in schools. Considering the importance of environmental topics in science education, our study provides a better understanding about the teaching and learning of these topics in school contexts.

S2.18.2 Measuring the Effectiveness of the Ecology Disrupted Approach for Student Learning of Ecological Principles, Human Impact and the Nature of Science

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

ABSTRACT: This research investigates whether curricular units that link environmental issues to ecological principles through analysis of real data from published research on the environmental impacts of familiar everyday activities improve student learning of ecological principles and daily life in the context of human environmental impacts and the nature of scientific activity. In the Spring 2010, six New York City public high school teachers pilot-tested in their introductory biology classrooms two Ecology Disrupted case study modules based upon data from published ecology research and constructed around a question that asks students to use data and prior knowledge to link everyday human actions to an environmental issue. One case study asks "How might snowy and icy roads be connected to Baltimore area's water supply?" and the other asks "How might being able to drive between Los Angeles and Las Vegas in just four hours put the bighorn sheep at risk?" Students completed pre and post-tests before and after they completed the Ecology Disrupted modules. Results from the pre/post tests indicate that these modules are effective for increasing student learning of ecological principles in the context of human impact, human impact in the context of daily life, and of the nature of science.

S2.18.3 Contradictions? What Contradictions?: Science Teachers do Environmental Education

Michael Tan, University of Toronto, mike.tan.lt@gmail.com

Erminia G. Pedretti, University of Toronto

ABSTRACT: While environmental education appears a natural fit for science education approaches interested in socio-political, social justice and ameliorative perspectives, significant theoretical contradictions exist that call for more research to be done on the curricular and pedagogical aspects of this combination. In this paper, we report on the results of a study of three teachers as they plan, implement and assess a science content unit taught through an environmental context. Using qualitative narrative analysis methods, we examine teachers' intentions and decision making when integrating environmental contexts in their science classrooms. We found that teachers were mostly unconcerned with theoretical contradictions, making use of working compromises to get on with the business of teaching. Structural factors and entrenched patterns of relation continue to serve as obstacles to effective practice, diluting the critical intent and potential for social change. Implications for educators are discussed.

S2.18.4 An Ethnographic Experience of a Place-based Learning Environment

Carlos Gustavo A. Ormond, Simon Fraser University, cormond@sfu.ca

David B. Zandvliet, Simon Fraser University

Susan Teed, Simon Fraser University

ABSTRACT: The reporting style of this paper follows an ethnographic format in describing one elementary school's experiences in achieving their environmental literacy goals, through the development of a place-based learning environment over a period of five years. This format has been purposefully employed so as to acknowledge and recognize an alternative approach to traditional academic and science texts in reporting the results of research. In September 2005 a project began at a Canadian elementary community school (CECS) to support and encourage the development of a place-based learning environment, in addition to helping the school realize its broad environmental learning goals. The model that was adopted for the involvement of teachers in studying their own classroom environments follows a participatory action research (PAR) methodology, which allows teachers, as participants of the study, to be co-investigators and co-creators of knowledge of the research. We hope to have created a story-map showing how environmental education is being done in one part of the world, with the goal of sharing this knowledge with others who see a need for the development of this form of learning.

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PL1 Plenary Session #1

New Urban Leaders for Sustainable Cities of the Future

4:30pm – 6:00pm, Grand Sierra E

Presider: Dana L. Zeidler, University of South Florida

Keynote Presenter: Kalanithy Vairavamoorthy, University of South Florida

ABSTRACT: Cities all over the world are facing a range of dynamic regional and global change pressures, such as climate change, population growth, urbanization, deterioration of urban infrastructure systems and more. Due to these pressures cities of the future will experience difficulties in efficiently managing scarcer and less reliable resources. The current models of resource management, and their corresponding infrastructure, originated from the 19th century, when populations were relatively small, and there was a view that resources were abundant and the environment benign. Unfortunately, remnants of this 19th century model are deeply embedded in our thinking and it has been institutionalized in business, politics and education.

There is a fundamental need for change at the system-wide level in the way we manage our resources, based on a foundation of research, technology and innovation. Technology breakthroughs and innovative designs need to be coupled with comprehensive system changes to the urban processes that shape our cities. These complicated challenges calls for a new generation of urban leaders with radically different thinking, informed by an understanding of human and natural systems, to deliver a real paradigm shift in environmentally sustainable urban management.

In addition, we need to address the lack in uptake of new science. Creating the imperative for change is extremely difficult, as it requires a change in the mindset of people — governments, financiers, consulting firms and the general public. One way science educators may address this issue is through learning alliances — local multi-stakeholder platforms that guide and support the development and implementation of scientific research.

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Presidential Sponsored Session

S3.1 Symposium - The Cyberlearning Research Agenda: A View from NSF?

8:30am – 10:00am, Antigua 1

President: Troy D. Sadler, University of Florida

Janet Kolodner, National Science Foundation, jkolodne@nsf.gov

Nancy B. Songer

Chris Quintana

ABSTRACT: In this session, a NSF Program Officer and Principal Investigators will discuss new developments in Cyberlearning. The presentation will focus on how the National Science Foundation is conceptualizing a new research agenda in this area.

External Policy Committee & Strand 15: Policy Sponsored Session

S3.2 Symposium - Exploration and Critique of the NRC's New Conceptual Framework for Science Education Standards

8:30am – 10:00am, Antigua 2

President: Andrew Shouse, University of Washington

Discussants:

Charles W. Anderson, Michigan State University

Nancy W. Brickhouse, University of Delaware

George E. DeBoer, American Association for the Advancement of Science

Presenters:

Heidi Schweingruber, National Research Council

Sharon Lynch, George Washington University

Elizabeth A. Davis, University of Michigan

Sarah J. Carrier, North Carolina State University

ABSTRACT: This session will focus on the science standards framework currently being developed by an expert committee of the National Research Council. The NRC anticipates a final, public draft of the framework in early 2011. The framework, once completed, will serve as the basis for the development of national standards under the auspices of the non-profit organization Achieve. (That stage in the process is the subject of the related session proposal, The Development of New Science Standards Aligned with NRC's Framework). Presenters will describe the goals and processes of the framework development project. They will also critique the major organizing elements of the framework. For example, the publicly released draft of the framework included "cross-cutting elements," emphasized practices of science learning, and learning progressions, and authors strove to focus on "fewer, clearer, higher" learning outcomes. In principle these organizing elements are resonant with prior efforts to define K-12 science education. Presenters will clarify the intent of the framework in light of prior efforts and critique the framework. The confirmed participants in this session include NRC project staff, senior scholars in the NARST community, and seasoned veterans of the national standards-development dialogue. Heidi Schweingruber, Associate Director of the NRC's Board on Science Education, and Director of the frameworks project, will lead off with a 30-minute overview of the project. Schweingruber will describe the NRC framework development process, including project goals, the expertise and knowledge base of the authoring committee, and the nature and scale of public commentary and review. Following Schweingruber, Anderson, Brickhouse, and DeBoer will each provide 10 minutes of prepared commentary and critique. The remaining 30 minutes will be split between moderated discussion of the panelists and question and answer with audience members.

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Strand 1: Science Learning, Understanding and Conceptual Change

S3.3 Learning Science in High School and College

8:30am – 10:00am, Curacao 1

Presider: Janelle M. Bailey, University of Nevada, Las Vegas

S3.3.1 What Is More Effective - Learning With Worked-Out Examples Alone Or In Pairs?

Iris Mackensen-Friedrichs, IPN -Leibniz Institute for Science and Mathematics Education Kiel, Germany,
mackensen@ipn.uni-kiel.de

Markus Luecken, IPN -Leibniz Institute for Science and Mathematics Education Kiel, Germany

Alexandra Schautz, University of Hildesheim Germany

ABSTRACT: What is more effective - learning with worked-out examples alone or in pairs? Especially learners with lower domain specific pre-knowledge prefer and benefit from learning with worked-out examples in comparison to learning with pure problem-solving tasks. The effectiveness of learning with worked-out examples depends on how thoroughly the learners study the given solution and how intensively they create self-explanations in respect to this solution. It might be more effective for students to learn by peer interaction instead of learning alone. In our study 152 ninth graders from German high school learnt with biological worked-out examples in pairs (51 dyads) or alone (50 students). With a pre-test and post-test we measured individual learning outcomes. At the first glance, our results indicate that when learning with worked-out examples in biology, working alone is more effective than studying in pairs, independent of the learners' pre-knowledge. Because of further analysis we found first pointers that students with higher pre-knowledge achieve higher learning outcomes by learning in pairs than by learning individually.

S3.3.2 Navigating Deep Time: Landmarks from the Big Bang to the Present

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

ABSTRACT: Understanding deep time is a central problem in the study of science domains including evolution and geoscience, and may help students understand the common themes (AAAS, 1993) of constancy and change, and scale. Related to the conference topic of global sustainability and public understanding of science, an understanding of multiple scales of time is required to understand how short, medium, and long-term trends interact to affect global weather patterns and other key environmental and societal challenges of our time. Prior research and theory show that learners use landmark objects and categories to make sense of the world. This study reports on 48 undergraduates taking an interdisciplinary Geoscience/History course that covered events from the Big Bang to the present, at a public research university in the Midwestern USA. The undergraduates' pre-course landmarks included the Big Bang, the age of empires, and the Cold War. After the course, the emergence of modern nation-states and the formation of the solar system were added as landmarks. The age of non-landmark events was usually underestimated. Students conceptualized three eras: human era, a pre-human biotic era, and a pre-biotic era. Implications for instruction and curriculum development are presented.

S3.3.3 Increasing Inferential Comprehension of Science Texts Using Elaborative Interrogative Study Questions

William G. Holliday, University of Maryland, holliday@umd.edu

Cynthia A. Ghent, Towson University

Stephen D. Cain, Montgomery College

Janice M. Bonner, College of Notre Dame of Maryland

ABSTRACT: Scientists spend their study time comprehending challenging texts, yet reading challenging science texts is seldom explored by science educators. We contributed to a series of studies in science teaching by providing support for a powerful questioning strategy consistently shown useful in past clinical conditions (e.g., increased recall among middle school students by more than 280 %). College students (N=146) were randomly distributed to three groups: (a) an experimental treatment group asked to read a portion of their course textbook once and correct (i.e., make true in writing) a set of 12 one-sentence statements pulled from the text at a frequency of about every 200 text words. These 12 pulled statements were transformed earlier by the researcher into false statements, as outlined in the elaborative

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interrogation (EI) theory based on increasing retrieval and activation of relevant prior knowledge; (b) a placebo-control group asked to re-read the same text; and (c) a second baseline placebo-control group used to establish that inferential comprehension indeed occurred, as predicted. ANOVA supported the hypothesis that EI-based questioning strategy in terms of an inferential comprehension posttest (Cronbach's $\alpha = 0.86$), as predicted ($p < 0.01$) and between the treatment and re-reading placebo-control, and re-reading and baseline placebo-controls.

Strand 2: Science Learning: Contexts, Characteristics and Interactions**S3.4 Context and Learning Environment**

8:30am – 10:00am, Curacao 2

President: Noemi Waight, University at Buffalo**S3.4.1 Analyzing Influences of a Real-life Context Compared to a Subject-related Context on Students' Interest and Achievement**Eva Kölbach, eva.koelbach@uni-due.de

Elke Prof Sumfleth

ABSTRACT: Due to the consistent disinterest of students in doing and learning science teaching with connection to real-life phenomena – called contexts – has become more important over the last decades. For teaching with real-life contexts Krapp (1998) suggested that they can enhance students' situational interest and, an increased interest can affect students' learning achievement. Due to this suggestion, common research has shown positive effects of contexts on students' interest, but effects on students' achievement are, so far, inconsistent and less positive. Hence, the present study investigated effects of a real-life context compared to a subject-related context on students' situational interest and their learning achievement. Thereby, worked-out examples served as context-based learning material. Context-effects were measured in a pre-post design, conducted by paper-pencil tests. Male- students in the real-life context-group showed a higher learning achievement than male students learning in the subject-related context-group.

S3.4.2 Employing a Culturally-based Context as a Means to Science Agency: Snow Snakes and STEMBrant G. Miller, University of Idaho, mill3770@umn.edu

Gillian H. Roehrig, University of Minnesota

ABSTRACT: This paper discusses the development of student science agency as a result of experiencing a culturally-based science, technology, engineering, and mathematics (STEM) curriculum that used the traditional American Indian game of snow snakes as a situating context. STEM was viewed as an integrated construct where each discipline works in unison providing students with content and context-specific problems to solve. Science agency was defined as an expressed behavior that illuminates positive dispositions toward STEM for the purposes of taking action in a student's individual life. A case study research design was used. Results indicate evidence of science agency, identification of experiences that foster science agency, preliminary model development, and insights into partnering with elders.

S3.4.3 Relationship Between Pre-Service Elementary Science Teachers' Argumentation Quality About Climate Change and Epistemic Belief LevelsErdinc Isbilir, Middle East Technical University, isbilir@metu.edu.tr

Hamide Ertepinar, Middle East Technical University

Jale Cakiroglu, Middle East Technical University

ABSTRACT: This study aimed to investigate the relationship between pre-service science teachers' (PSTs) quality of written argumentations about climate change issue and their epistemic belief levels. To do this, the researchers developed an online discussion environment which included two contrasting views about climate change issue in order to promote PSTs to generate and defend arguments for a period of one-week. A total of 30 PSTs enrolled in Science, Technology, and Society course were purposefully selected for this study. The PSTs' epistemic belief levels were measured by the Epistemic Beliefs Assessment developed by Kuhn, Cheney, and Weinstock (2000) according to which PSTs were categorized into absolutist, multiplist, and evaluativist belief levels. The quality of PSTs' written

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argumentations was identified by a modified version of Sadler and Fowler's (2006) argumentation quality framework. The relationship between PSTs' argumentation levels, frequencies of arguments and epistemic belief levels were described in terms of Pearson product-moment correlations. The results illustrated that PSTs generated mostly higher levels of argumentations and that the PSTs' levels of argumentation quality and the frequencies of arguments were related to their epistemic belief levels. The findings are particularly informing for science education researchers in designing science learning environments.

S3.4.4 Multimedia Text-Synergy: A Pedagogy to Bridge Adolescents and School Science Literacies

Kok-Sing (Kenneth) Tang, University of Michigan, koksing@umich.edu

Stephen Tighe, Lake Orion High School

Elizabeth Moje, University of Michigan

ABSTRACT: We present research findings of a learning environment called Multimedia Text-Synergy that has the potential to: (a) bridge adolescents' out-of-school interests and experiences about the natural world to science instruction, and (b) develop a critical form of science literacy. The central tenet of Text-Synergy is to recruit and integrate students' out-of-school texts and media into formal classroom curriculum and assessment. Based on a design-based research in a high school physics classroom, we document the overall conceptualization, curricular procedures, data collection methods, analysis, and evaluation of Text-Synergy. From our research and findings, we claim that the students were more engaged as they related their interest areas to the study of physics, and at the same, gained some competency to read beyond the content of a text/media and critique how science is represented across out-of-school and school science domains. We also draw attention to several issues that augment the theoretical constructs of student attitudes, engagement, and hybrid third space. Finally, we highlight effective pedagogies that can aid classroom teachers bring about a closer connection between adolescents' life-world and science.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S3.5 Poster Symposium – Supporting Elementary and Middle School Students in Developing, Using, and Refining Scientific Models

8:30am – 10:00am, Antigua 3

President: Christina V. Schwarz, Michigan State University

Presenters:

Brian J. Reiser, Northwestern University

Andres Acher, Northwestern University

Lisa Kenyon, Wright State University

Hamin Baek, Michigan State University

Michele Nelson, University of Michigan

Yael Bamberger, University of Michigan

James A. Hagerty, University of Michigan

Li Zhan, Michigan State University

Jing Chen, Michigan State University

ABSTRACT: In this interactive symposium, we will present an integrated set of posters addressing how both students and teachers interpret and enact aspects of the scientific modeling practice. The research examines challenges that emerge and ways that students and teachers succeed in the complex practice in classroom interactions. All the work stems from a shared conceptualization of modeling practices as modeling performances and metamodeling knowledge, as defined by the two constructs with four common dimension in our learning progression. The work with teachers examines how students and teachers interact in elementary classrooms as they makes sense of and enact modeling practices. It also examines preservice teachers' growth in understanding of modeling as they engage in teacher education activities designed to promote their pedagogical content knowledge about scientific modeling. The work with students explores both elementary and middle school students engaged in modeling with a range of science content. In this work we identify the aspects of modeling performances and metamodeling knowledge that student develop, and

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the challenges that emerge. The session will consist of a brief introduction, poster interactions, and a discussion to synthesize main findings and address observations and questions from the audience.

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

S3.6 Teaching/Learning Science from Multiple Perspectives

8:30am – 10:00am, Curacao 3

President: Deborah J. Tippins, University of Georgia

S3.6.1 Examining Culturally Responsive Teaching Practices over Three Enactments of a Personally Consequential Elementary Science Unit

Christopher J. Harris, SRI International, christopher.harris@sri.com

Patrik Lundh, SRI International

Hannah Lesk, SRI International

Liliana Ructtinger, SRI International

Carlin Llorente, SRI International

William R. Penuel, SRI International

Carrie Tzou, University of Washington, Bothell

Philip Bell, University of Washington

ABSTRACT: Emerging research indicates that science instruction for diverse student groups can be more effective when teachers are responsive to the funds of knowledge students bring to school. A critical need is to better understand how culturally responsive teaching practices can be taken up by teachers and become an integral part of their science teaching. We conducted a study to examine the teaching practices of an elementary teacher who enacted culturally responsive science instruction supported by an innovative microbiology and health unit. The unit was designed to support teachers in leveraging students' culturally based ways of knowing for science teaching and learning. In our case study, we identified and described instructional moves that were characteristic of the teacher's culturally responsive instruction and explored these teaching practices across the timeframe of three enactments over three school years. Central to our analysis were video records of science instruction taken during each enactment. We employed a scheme to pinpoint and characterize culturally responsive interactions and develop the case from patterns of evidence. Findings illustrate the dynamic growth of a teacher's culturally responsive practice over multiple enactments and contribute to our understanding of how science instruction can be made more relevant and accessible for students.

S3.6.2 Dramatic Science: Using Theatrical Techniques to Teach Primary (or Elementary) Science

Debbie J. McGregor, University of Wolverhampton, debmcgregor@btinternet.com

ABSTRACT: The Dramatic Science approach is comprised of eight different theatrical techniques. This paper reports on the development of the project (from September 2009 to July 2010) with ten schools in Staffordshire, UK. The approaches include enacting stories about scientists from the past; modeling scientific processes; discussing and communicating reflections about the nature and impact of science. The approaches embrace active, engaging, participatory and exciting ways to learn science. Reflections from the teachers and children provided insightful 'learning stories' about their experiences. The teachers indicated that dramatic science influenced the way they taught science in a number of ways. They reported that they were now much more aware of children's prior conceptions, and that learning activities were now much more active, participatory and more fun. The drama activities also involved more contemplation about concepts, group discussions of collective ideas and additional reflective talking about science. The children indicated the project has helped them understand the science better through being more engaged with it and having to think about it carefully to transform their ideas into a more dramatic form.

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

S3.7 Investigations of Science Teachers' Knowledge and Beliefs

8:30am – 10:00am, Curacao 4

Presider: Toni A. Sondergeld, University of Toledo

S3.7.1 Comparison of Pre-Service and In-Service Teachers' Content Knowledge and Pedagogical Content Knowledge in Chemistry

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

Sabrina Witner, University of Duisburg-Essen Chemistry Education

ABSTRACT: Professional knowledge of teachers is one of the most relevant factors for successful teaching. Two of the most frequently discussed dimensions of teachers' professional knowledge, content knowledge and pedagogical content knowledge, are to be focused on in this project within the context of chemistry instruction. Referring to Shulman, content knowledge is assumed to be a precondition for the development of pedagogical content knowledge, while both dimensions should be distinct from each other. Thus, investigating the relation between content knowledge and pedagogical content knowledge is one important aspect of this study. Because pedagogical content knowledge is presumed to develop over years in practice, the possible difference between pre-service and in-service chemistry teachers is also examined. To these ends, a large-scale test instrument has been developed. A total of 105 pre-service and in-service chemistry teachers of different school forms were asked to fill out a multiple choice test which was presented in either a hardcopy (paper/pencil) format or online. The study revealed significant differences between pre-service and in-service teachers, and also between different school forms. Furthermore, significant but varying correlations between content knowledge and pedagogical content knowledge could be found based on educational level.

S3.7.2 Physics Teachers' Content Knowledge and Pedagogical Content Knowledge: Developing Test Scales and Measuring the Relation

Sophie Kirschner, University of Duisburg-Essen, Germany, sophie.kirschner@uni-due.de

Andreas Borowski, University of Duisburg-Essen, Germany

Hans E. Fischer, University of Duisburg-Essen, Germany

ABSTRACT: The study deals with physics teachers' professional knowledge. For this purpose, model-based test scales for assessing pedagogical content knowledge (PCK) and content knowledge (CK) for physics teachers were developed. The model covers cognitive knowledge areas, themes and facets concerning school. It could be shown that the scales are valid (through a comparison of 93 physics teachers with 14 non-physics teachers and 15 professional physicists) and show good internal consistencies ($\alpha(\text{PCK})=.72$ and $\alpha(\text{CK})=.83$). The significant correlation between PCK and CK ($r = .522$; $p<.001$) shows that physics content knowledge and pedagogical content knowledge have a strong overlap. Further analyses, including covariates such as professional experience, age or gender, indicate that CK is required, but not sufficient to expand PCK. Future teacher education should thus focus on more than just conveying content knowledge to students.

S3.7.3 Autonomy and Self-Determination Theory in Different Contexts: A Comparison of Middle School Science Teachers' Motivation and Instruction in China and the United States

Laura E. Robertson, East Tennessee State University, lrobert@ncsu.edu

M. Gail Jones, North Carolina State University

ABSTRACT: This study examined factors that contribute to Chinese and United States middle school science teachers' perceptions of autonomy support. The study used a mixed methods design including quantitative data collected through an online survey and qualitative data collected through open-ended interview questions. The online survey allowed for the testing of the structural model developed by Pelletier, Seguin-Levesque, and Legault (2002) using exploratory factor analysis (EFA) of responses for the combined teacher sample ($n = 201$). Significance testing for Chinese ($n = 107$) and U.S. ($n = 94$) teachers, based on the factors resulting from EFA, revealed significant differences in teachers' self-

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determination and perceptions of constraints at work. Multiple regression was used to predict teachers' autonomy support for students. Significant differences were found in the predictor factors for Chinese and U.S. teachers. A sub-sample of the Chinese and U.S. science teachers ($n = 19$) were interviewed. Teachers in both countries reported that autonomy was important to their motivation and the quality of instruction they provided to students. Teachers from the two countries differed in their satisfaction with current levels of autonomy and reported different constraints on teaching science related to materials, lab space, curriculum standards, and assessment.

S3.7.4 Linking Expert Science Teachers Values with their Practice

Deborah J. Corrigan, Monash University, debbie.corrigan@monash.edu

Rebecca Cooper, Monash University

Stephen Keast, Monash University

Donna King, Queensland University of Technology

ABSTRACT: This paper reports on how expert science teachers' conceive of what values they hold in relation to science and science education (and particularly scientific literacy) and how their conceptions and underpinning values affects their teaching practice. Three perceived expert science teachers who teach both at senior and middle high school levels and across the range of sub-disciplines (biology, chemistry and physics) were interviewed about their understanding of science, science education and scientific literacy and how this influenced their teaching practice. The three teachers were video recorded teaching a middle and a senior high school science class. The data were analysed to identify values that underpin their conceptions of science, science education and scientific literacy. Particular attention has been paid in the analysis to the matching of the verbalised conceptions and values with their practice of teaching science. This paper will report on these data. Part of a large study looking at teachers notions of scientific literacy, this paper considers the similarities and differences of the notions of teachers from different states of Australia and what may impact their ideas and actions in the classroom.

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

S3.8 Mentoring and Development of Graduate Students

8:30am – 10:00am, Curacao 5

Presider: N. Sanjay Rebello, Kansas State University

S3.8.1 Understanding Student Evaluations of their Doctoral Advisors

Geoffrey Potvin, Clemson University, gpotvin@clemson.edu

Mark D. Harmon, Clemson University

Robert H. Tai, Curry School of Education University of Virginia

ABSTRACT: One of the most important parts of the graduate science experience is the advisor-advisee relationship. We study students' ratings of their satisfaction with their current doctoral advisors and examine which aspects of the advisor-advisee relationship have a significant impact on their satisfaction. We use data from more than 1000 currently-enrolled graduate students in physics and chemistry that was collected as part of a national study of chemists and physicists. Our results indicate that, on average, students are more satisfied with more frequent interactions about their dissertation research and prefer more collaborative, and less authoritative, relationships. Interestingly, the context under which a student chose (or was chosen by) their dissertation advisor has an influence over their subsequent satisfaction: those students who were directly recruited tend to be less satisfied, while those who chose their advisors based upon their reputation as a mentor or their personality tend to be more satisfied. Lastly, we examine possible gender effects and find that while gender (of student and advisor alike) has no direct influence on satisfaction, a factor that assesses the influence of "advisor's gender" on the advisor-advisee relationship does influence student satisfaction.

S3.8.2 What Students and Graduate Programs Can Do to Reduce Doctoral Completion Times

Geoffrey Potvin, Department of Engineering & Science Education, and Department of Mathematical Sciences Clemson University, gpotvin@clemson.edu

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Adam V. Maltese, Indiana University
Joseph A. Harsh, Indiana University
Robert H. Tai, Curry School of Education University of Virginia

ABSTRACT: This paper examines doctoral completion time amongst PhD holders in physics and chemistry. By analyzing the responses of over 2000 individual scientists, we develop a model that predicts doctoral completion time using several different factors related to graduate experiences, research issues, and institutional/departmental factors. To illustrate the impact of these factors, we compare a pair of hypothetical students who have a set of typical, but somewhat differing, graduate experiences and show the impact of these differences on completion times.

S3.8.3 Characterizing Strategies Used by Graduate Students in Field Ecology for Coping with Research Challenges

Mika Leon-Beck, The Hebrew University of Jerusalem, mikabeck@gmail.com
Jeff Dodick, Science Teaching Center, The Hebrew University of Jerusalem

ABSTRACT: Recently science education researchers have been characterizing the epistemic practices of lab-based research students; however, such work ignores field sciences. In this paper we characterize the strategies used by graduate students in ecology to cope with research challenges, via a qualitative (In-Vivo) study of such students. We present a general model consisting of two components: knowledge elements needed for implementing research, and the resultant field-based research skills, which are expressed by coping strategies the students adopt when facing research challenges. Our findings suggest that fieldwork is the critical source of practical knowledge influencing three different coping strategies: “preserving the initial research plan”, “adapting the plan” and “redefining the plan”; these strategies were observed at all stages of the students research and were based on the students’ experience. Thus, the most novice students tended to preserve their plans while more experienced students would either adapt or redefine their plans, based on their better understanding of uncontrolled natural environments. Recognizing such coping strategies will help novice students better cope with fieldwork challenges, as well as help their advisors better guide them through this process. This work also has implications for designing inquiry curricula in field sciences for university and high school students.

S3.8.4 Faculty Mentor-Graduate Student Coauthoring: The Precursors, Processes, and Outcomes of 'Scholarly Bricklaying'

Michelle A. Maher, University of South Carolina, mmaher@mailbox.sc.edu
Briana E. Timmerman, University of South Carolina
David F. Feldon, University of Virginia
Denise Strickland, University of Virginia

ABSTRACT: This study explores the STEM (science, technology, engineering and math) faculty mentor-graduate student mentee coauthoring process. Study questions included who initiated the process and why, what roles and activities define the process, what student research competencies STEM faculty mentors seek to develop, and to what extent variation exists in responses to these questions by disciplinary affiliation and faculty rank. Findings suggest both commonalities and differences in roles and activities, and suggest that the coauthoring process is an important one to understand for reasons beyond student development.

Strand 6: Science Learning in Informal Contexts

S3.9 Outcomes and Outreach: Bridging the Gap in Informal Science Education

8:30am – 10:00am, Curacao 6

President: Susannah K. Sandrin, Arizona State University

S3.9.1 The Enduring Effect of Formal Science Learning on Adult Informal Science Learning

Jon D. Miller, University of Michigan, jondmiller@umich.edu

ABSTRACT: Herbert Hyman's seminal work on The Enduring Effects of Education (1975) provided a strong quantitative case for the lasting impact of formal education throughout the life cycle. This paper utilizes two streams of data – a 22-

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year longitudinal study of middle-school and high school students and three decades of national cross-sectional surveys – to demonstrate the enduring effect of school science learning on adult scientific literacy and on the ability of adults to make use of the wide array of informal science learning resources now available. The analysis finds that pre-college science and mathematics courses predict access to and success in college-level science courses and that college science courses are the strongest predictors of adult scientific literacy and the ability to access, use, and understand the growing array of informal science learning resources available today. The expansion of the Internet and related electronic learning resources has magnified the impact of formal education on informal adult science learning. The paper concludes with a discussion of strategies to improve linkages between formal and informal science learning.

S3.9.2 Factors Contributing to Adult STEM Knowledge

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

ABSTRACT: Understanding science, technology, engineering and mathematics (STEM) is an increasingly important part of the daily lives of all citizens. Despite the considerable investment of resources by many for many years to improving public STEM education, a range of indicators suggest that the publics' overall understanding of STEM remains relatively unchanged and well below expectations. These results argue for the need to critically review the various educational activities that currently lead to adults' understanding of STEM. This study specifically investigated the relative contributions to adult science knowledge of variables such as schooling, various adult and childhood free-choice learning experiences, work-related experiences and the role of "privilege" (e.g., income, race/ethnicity and gender). Regression analysis revealed that the best predictors of adult science knowledge, in descending order were: 1) Adult free-choice learning experiences; 2) Demographic variables; 3) Childhood experiences; 4) Direct occupational activities; and 5) Years of schooling. The findings raise questions about the current disproportionate investment in school-based STEM education as compared with out-of-school STEM education. If nothing else, the results of this study provide strong support for the importance of increasing federal, state and local support of free-choice science learning experiences for both children and adults.

S3.9.3 Experiences with the Informal Science Education Program's Transformation from Documenting Outputs to Measuring Outcomes

John P. Wells, Westat, johnwells@westat.com

Gary Silverstein, Westat

ABSTRACT: The paper summarizes data from the National Science Foundation's Informal Science Education (ISE) Program and to discuss the opportunities and challenges associated with the ISE Program's transformation from documenting outputs (i.e., the number exposed to ISE activities) to measuring outcomes (i.e., benefits that occurred as a result of being exposed to ISE activities). Of particular interest is information pertaining to the type and quality of project-level impacts and the corresponding study designs and data collection activities delineated by the projects that participated in an initial pilot test of the ISE Online Project Monitoring System (OPMS). Data collected through the OPMS are used to examine the collective impact of the ISE portfolio of funded projects, to monitor participants' activities and accomplishments, and to inform the design and implementation of future ISE projects. The paper also discusses some of the challenges that ISE projects encountered in specifying and measuring progress toward audience outcomes—as well as steps taken by the ISE program and individual projects to overcome those challenges. This paper provides important information on lessons learned from one of the first attempts to systematically document outcomes in informal science education settings.

S3.9.4 Exploring Impacts of Professional Development for Informal Science Educators

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

Susan Magdziarz, Crystal Cove Alliance

Maria Grant, California State University, Fullerton

Donna Ross, San Diego State University

Amy Cox-Petersen, California State University, Fullerton

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ABSTRACT: Given the current interest in supporting STEM learning, it seems reasonable that informal science education institutions might be tapped to support these efforts. Yet how do the science educators who work and teach in these institutions develop their practice? What does professional development look like, and how might the effectiveness of training efforts be documented, especially when there are no 'student scores' to compare? This presentation examines the impacts of a professional development project aimed at supporting science educators working in informal settings. Both quantitative and qualitative data was used to assess changes that may have resulted from participation in the program. Findings suggest that the workshop series resulted in three areas of outcomes: personal impacts, institutional impacts, and professional community development. Implications for additional documentation of professional development effectiveness will also be discussed.

Strand 7: Pre-service Science Teacher Education

S3.10 Preparing Teachers to Teach Diverse Learners

8:30am – 10:00am, Curacao 7

Presenter: Felicia Moore-Mensah, Columbia University

S3.10.1 Preparing Preservice Elementary Teachers to Teach Science in Culturally Relevant Ways

Neporcha Cone, Northern Kentucky University, neporcha@yahoo.com

ABSTRACT: Social-cognitive theory served as the framework to examine the effect of community-based service-learning (CBSL) on preservice teachers' beliefs about multicultural science education. Participants included 46 undergraduates enrolled in two sections of an elementary science methods course. The course's service-learning component provided preservice teachers opportunities to teach science to African-American and Hispanic children from low socioeconomic backgrounds. Participants described their experiences via semi-structured interviews and post-questionnaires. Analyses of the multiple data sources indicated that weekly interaction with the children broadened participants' understandings of diversity, changed their preconceived stereotypes, and impacted their expectations of student success.

S3.10.2 Developing Pre-Service Elementary Teachers' Capacity to Design Science Instruction for English Language Learners

Meredith E. Houle, San Diego State University, mhoule@mail.sdsu.edu

Michelle Nolasco, San Diego State University

ABSTRACT: Given the increasing linguistic, cultural and ethnic diversity of our students and the recognition that they are vastly underrepresented in fields of science, it is critical that elementary school teachers have the capacity to leverage available curricular resources to design challenging science learning experiences. One role of teacher preparation programs is to build this capacity. In this case we examine 26 elementary preservice teachers' enrolled in a credential program explicitly decide to prepare them to teach science to English language learners. In this study, we use mixed method approach to examine the development of preservice teachers' pedagogical design capacity, or their ability to leverage personal and curricular resources, to plan science instruction for their linguistically diverse students.

S3.10.3 Preservice Teachers' Uptake and Understanding of Funds of Knowledge in Elementary Science

David S. McLaughlin, Susquehanna University, mclaughlind@susqu.edu

Angela M. Calabrese-Barton, Michigan State University

ABSTRACT: We use a "learning to notice" framework to suggest that preservice elementary teachers bring a range of interpretations and responses to their students' funds of knowledge and science teaching and learning. By examining data from three sections of an elementary methods course where fourth-year preservice elementary teachers explored ways to make science teaching meaningful, relevant, and engaging for diverse students, we describe the ways that preservice teachers appropriated and made sense of the concept of funds of knowledge in their analysis of classroom events and in their science lesson planning. We find that preservice teachers recognized students' funds of knowledge, assigned value to them, and took account of these resources for science learning in their planning. While preservice teachers most often described funds of knowledge as a "hook" to gain and sustain students' interest in the science

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classroom, they also interpreted and utilized funds of knowledge in other ways, including as substantive contributions to meaning making and positioning students as having expert knowledge.

Strand 7: Pre-service Science Teacher Education

S3.11 Topics in Physics & Space Science

8:30am – 10:00am, Bonaire 7

President: Bruce R. Patton, The Ohio State University

S3.11.1 Investigating Elementary Education and Physical Therapy Majors' Perceptions of an Inquiry-Based Physics Content Course

John M. Hilton, Delaware Technical & Community College, jhilton1@dtcc.edu

ABSTRACT: This study investigates why physical therapy assistant majors engage and perform better than elementary education majors in an inquiry-based conceptual physics course at a Mid-Atlantic Community College. The students from each major are demographically similar, both courses are similar in depth and structure, and each course supports the students' program. However, there is an observed difference in the levels of engagement with the curriculum and performance on writing-based assessments between the two groups. To explore possible explanations for the difference, I examine students' affinity for science, their beliefs about the nature of science and scientific knowledge in the classroom, and their perception of the usefulness of science to their program. During semi-structured interviews, students from both majors displayed nearly identical weak affinities for science, epistemological beliefs, and uncertainty about the usefulness of the class. However, the physical therapy majors' ability to see the relevance of the physics content to their program enhanced their interest and motivation. In contrast, the elementary education students do not see connections between science content and their program, and they do not see a purpose for their learning of physics content.

S3.11.2 Teaching and Learning through a Project-based Unit Implemented with Future STEM Educators: A Design Study

Jennifer A. Wilhelm, University of Kentucky, jennifer.wilhelm@uky.edu

ABSTRACT: This study documented means by which future STEM educators (pre-service and in-service teachers) experienced the science and mathematics associated with understanding lunar phenomenon. The paper reports how well STEM Education graduate students interacted with the project-based materials as they engaged in transdisciplinary teaching and learning. A mixed-methods approach was used with this semester-long design study to expose how focused project work facilitated understanding. Four groups of students were compared as they conducted project work that required the mathematization of the Earth, Moon, and sky. Significant gains were made on lunar-related concept domains that had been previously resistant to conceptual change. An implication of this design study suggests that the use of technologies such as Stellarium, Blackboard, and Geometers' Sketchpad facilitated project progress and aided understanding.

S3.11.3 Integrating Pedagogy and Content in an Undergraduate Physics Course: What was Learned?

Danielle B. Harlow, University of California at Santa Barbara, dharlow@education.ucsb.edu

Lauren H. Swanson, University of California at Santa Barbara

Hilary A. Dwyer, University of California at Santa Barbara

Julie A. Bianchini, University of California at Santa Barbara

ABSTRACT: We report on an adapted version of the Physics and Everyday Thinking (PET) curriculum, an introductory undergraduate physics course designed specifically for an audience of pre-service teachers. A unique aspect of PET is its inclusion of special activities that focus on Learning about Learning (LAL) in which undergraduates analyze videos of children talking about science and explicitly consider the nature of science and the nature of learning. To create a course that intentionally linked science content, children's ideas, and strategies for science instruction, we augmented the existing LAL activities with discussions about teaching, and added activities that focused explicitly on teaching science

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through inquiry. We used video recordings of class discussions, interviews with students, class assignments and surveys to understand the ideas about teaching science and the ideas about children as science learners that the undergraduates took up from the class. Here we report on our findings about what the undergraduates learned about teaching science through inquiry-based instruction.

Strand 8: In-service Science Teacher Education

S3.12 Symposium - Supporting Teachers in Teaching Science as Inquiry: What is the Evidence for Effective Professional Development?

8:30am – 10:00am, Curacao 8

Presider: Daniel K. Capps, Cornell University

Discussants:

Jan H. Van Driel, University of Leiden, The Netherlands

Judith S. Lederman, Illinois Institute of Technology

Presenters:

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

Daniel K. Capps, Cornell University

Julie A. Luft, Arizona State University

Norman G. Lederman, Illinois Institute of Technology

Aik Ling Tan, National Institute of Education in Singapore

Siew-Lee Shirley Lim, National Institute of Education in Singapore

Daniel P. Shepardson, Purdue University

Okhee Lee, University of Miami

John Loughran, Monash University in Australia

ABSTRACT: Many teachers struggle to enact inquiry-based instruction in their classrooms. Our intent in this symposium is to generate discussion among participants in order to bring forth recent empirical evidence related to effective strategies for supporting teachers in teaching science as inquiry. The symposium includes researchers from the U.S. and other countries. A recent review of the literature revealed very few empirical studies related specifically to science-inquiry professional development actually published in major peer-reviewed journals. We will pose these questions: 1) What are your views and framework for supporting teachers in carrying out inquiry in the science classroom? 2) What is the evidence for effective strategies of supporting teachers in learning to teach science as inquiry? Each participant will give a brief overview of the context of their PD programs, and then a summary of their recent research findings. During the session participants will highlight what has been learned about aspects of professional development, and issues that are particularly problematic and strategies that may not be effective. It would be important to develop an empirically based Inquiry Teacher Professional Development Framework. This symposium can contribute towards this goal.

Strand 9: Reflective Practice

S3.13 Reflection on Teaching Context

8:30am – 10:00am, Bonaire 6

Presider: Ratna Narayan, Texas Tech University

S3.13.1 Problematizing Reflection: Constructing a Cross-Cultural Researcher-Teacher Lens

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

ABSTRACT: In the last six years, specialized schooling in sports, arts, mathematics, science, and technology has emerged in the educational landscape of Singapore. I taught in such a school and engaged in curriculum planning, development, writing, and enactment after implementing the national curriculum for three years. In examining a U.S. chemistry teacher at the Illinois Mathematics and Science Academy (IMSA) initiate, rewrite, and enact curriculum changes to an advanced chemistry curriculum as a graduate student researcher, I reexamined and interrogated my prior experiences,

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knowledge, and experiences in curriculum making. I reflect-in-action through critical inquiry (Lather, 1993) into my narratives-in-interaction (Bamberg, 2004) with his narratives from lesson observations and interviews. This dialectic, recursive, reciprocal, and reflexive (Lather, 1993) course of action problematizes reflection as comfortable practice to critical praxis helping me to address questions about our teacher agency and role in curriculum making in a comparative context. These narratives and reflections become my analytical tools to capture deeper meanings behind the choices, decisions, movements, and changes in curriculum work. The analytical process is empowering and enlightening for me as an educator, researcher, and curriculum maker. The narratives could be shared with educators interested in critical understanding of teaching at specialized schooling.

S3.13.2 The Examination of The Third Space: A Self-Study

Dashia Magee, The College of New Jersey, dmagee@tcnj.edu

ABSTRACT: In this research study, I, a high school science teacher, examined my role in creating the third space in an English Language Learner's biology classroom. The concept of the third space stems from the works of Bhabha (1990, 1994) and Soja (1996), where they examine what happens when two distinct cultures meet and interact with one another. Therefore, in this paper the third space becomes an examination of the culture of students and the culture of science. A self-study methodology was employed to examine and better understand the teaching practices associated with the introduction of this approach. I believed, as a high school teacher, I was successful in creating the third space for my students, yet I wanted to go beyond the stories I told about my classroom, where the impressions and opinions were expressed not anecdotally but where developed from an evidence base from which to draw conclusions. Overall, this self-study offers a model for professional development that can be used as a model to share how one teacher explored her own approach to working with students who were culturally and linguistically different from her and so be a catalyst for encouraging exploration of similar approaches in others.

S3.13.3 Visualizing, Investigating & Remembering: Modelling a Critical Place-Based Science Education

Sheliza Ibrahim-Khan, Nipissing University, shelizai@nipissingu.ca

ABSTRACT: Scholarship in science and technology curriculum that encourage societal and environmental dimensions, are now turning to students' places to explore teaching and learning. Some of these studies explore projects proposed by outside initiatives, pay limited attention to collaborative and intergenerational partnerships; and rarely remembers its sustainability. To address these issues, I propose a model for critical place based science education (CPBSE). Through participatory action research, data collected such digital video, photographs, and written reflections, were analysed using the constant comparative method. The analysis yielded a pedagogical model of CPBSE that comprises of three stages: critical visualizing, investigating, and remembering. I explore this by sharing a case study that connects science to place using photographs. I discuss its implications for the field of STSE and place based education.

S3.13.4 Technology and Teacher Self-Reflection: Professional Development in the 21st Century

Dino Sossi, Teachers College, Columbia University in the City of New York, dino_sossi@yahoo.com

Janell N. Catlin, Teachers College, Columbia University in the City of New York

Denise Wynn

Margaret Hood

ABSTRACT: Existing technologies allow us to harness the communicative and social aspects of the internet in ways unimaginable only a short while ago. For example, new technological breakthroughs promote the creation of learning environments that foster the ability of both teachers and students to analyze, synthesize and disseminate ideas that incorporate visual and aural elements, among others. This research project implements an internet-based video interface to improve teacher professional development in the classroom. More specifically, this interface is used by 5th grade Collaborative Team Teaching (CTT) science teachers working within a university-school partnership focusing on improving Science, Technology, Engineering and Mathematics (STEM) education in urban schools.

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Strand 10: Curriculum, Evaluation, and Assessment

S3.14 Assessment with Secondary and Postsecondary Students

8:30am – 10:00am, Bonaire 1

Presider: Todd Milford, University of Victoria

S3.14.1 Closing the Feedback Loop: Assessment in an Introductory Physics Course for Non-Majors

Nilay Muslu, University of Missouri, nilaymuslu@mail.mizzou.edu

Deborah Hanuscin, University of Missouri

ABSTRACT: Effective teaching requires that instructors are aware of what students know and how they learn.

Assessment, particularly formative assessment, plays a key role in supporting student learning when it is used to inform instruction. Though the research literature has many examples of innovative science course reform efforts, few studies have examined assessment within these courses, particularly in courses that employ multiple components (e.g., lecture, laboratory, recitation) in which assessment is carried out by different instructors. The purpose of this study was to understand the way in which information about student learning is disseminated among faculty and teaching assistants (TAs) undertaking course reform efforts in an introductory physics course for nonmajors. The course was a pilot section (40 students) of an introductory physics course (algebra-based) for nonmajors at a large Midwestern university. For this pilot section, the professors worked with four TAs: two who taught laboratory, one who taught recitation, and one who worked as grader. Data were gathered through observations of class sessions and interviews with students, professors, and TAs. We will share a model “feedback loop” through which assessment data can be used to inform instruction in introductory science courses.

S3.14.2 Science Curriculum Reform in Senior Secondary Education in the Netherlands: A Comprehensive and Longitudinal Evaluation Study

Wilmad Kuiper, University of Utrecht / Netherlands Institute for Curriculum Development, w.kuiper@slo.nl

Elvira Folmer, Netherlands Institute for Curriculum Development

Wout Ottevanger, Netherlands Institute for Curriculum Development / Vrije University Amsterdam

Lucia Bruning, Netherlands Institute for Curriculum Development

ABSTRACT: The chemistry, physics, and biology curricula for senior secondary education in the Netherlands contend with poor coherence within and across subjects, and with a lack of content relevance. In addition, most programs are overloaded. The Ministry of Education has established Curriculum Reform Committees, each with the mandate to develop new examination programs based on a context-based approach. The reforms have been organized around subject-specific pilots which are subject to a comprehensive and longitudinal evaluation, meant to generate empirical evidence about the feasibility of the intended reforms. The research group consists of pilot school teachers and students. Data collection includes a.o. the administration of teacher and student questionnaires, and case studies. The paper describes and discusses evaluation results of the pilots.

S3.14.3 Formative Interactions in Learning to Teach Science

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

ABSTRACT: Despite repeated calls for reliable and valid assessments of teachers’ Pedagogical Content Knowledge (PCK), tools suitable for assessing the categories of 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 we might develop strategies in teacher education for science teaching and student teachers’ professional learning. This project highlights the potential to positively focus on formative assessment activities to capture and identify 24 primary science student teachers’ development of PCK over a semester. In the project, formative assessment consists of activities used by teacher educators to stimulate formative interactions, self and peer-assessment during a semester in order to provide insights into the development of student teachers’ learning to teach science. The question that frames the study is “How do formative interactions support student teachers’ development of PCK?” As such, the project aims to connect formative assessment with student teachers’ PCK development and, as a consequence, seeks to determine how an articulation of this knowledge can inform innovative and meaningful approaches to science teacher education.

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S3.14.4 Using Discussion in Online and Traditional College Courses

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Kristy L. Halverson, University of Southern Mississippi

Stephanie P. Williams, University of Southern Mississippi

Xiaolan Li, University of Southern Mississippi

ABSTRACT: Discussion is universally applied in both on-line and traditional face-to-face classes. It can be used in instruction to engage students in the learning process, assess students' understandings, initiate inquiry and promote the development of new understandings. But the evaluation of discussion is not standardized. The purpose of this research was to investigate how and why instructors use and assess discussion in the online and traditional classes. We interviewed three professors who taught both on-line and traditional classes and found that the instructors value discussion as an instructional strategy but use discussion differently in on-line and traditional formats. Additionally, we found that when instructors used discussion as an assessment tools, they only used it for formative assessment. This was largely because they were unfamiliar with summative evaluation techniques to use with discussion and there are no standards accessible for using discussion as an assessment tool. This study provides implications for developing standards to help facilitates stronger assessment practices using discussion.

Strand 11: Cultural, Social, and Gender Issues

S3.15 Cultural and Linguistic Diversity and Science Teaching: National and International Contexts

8:30am – 10:00am, Bonaire 2

Presider: Mercy Ogunsola-Bande, Adamawa State University

S3.15.1 Perceptions of Socio-Cultural Challenges and Opportunities in Science Education in Africa

Peter A. Okebukola, University of Science and Technology, Ifaki-Ekiti, Nigeria, pokebukola@yahoo.com

Olatunde Owolabi, Lagos State University, Ojo, Lagos, Nigeria

ABSTRACT: At the close of the 20th century, the report card of Africa in science and technology development was depressing. In the last five years however, optimism has risen. We report the findings of a two-year survey of 835 African scientists, science educators, senior policy makers and civil society groups on the major socio-cultural challenges and opportunities for Africa in the 21st century. The study also extracted from the subjects, perspectives on the directions Africa should turn in science and technology education in the next two decades. Four clusters of challenges emerged: low investment in science and technology education; scientific and technological illiteracy; poor science and technology infrastructure; and science and technology human capacity deficit. Elements of a reform agenda for science education in Africa were ranked by the participants in the study. These include increased investment in science education; development of national science education strategy; major rethinking of science teacher education programme and its implementation; greater visibility to environmental education, computer education and population education in the curriculum; promotion of scientific and technological literacy for all; and promoting the participation of girls in science. Important recommendations were made for national and regional science education systems in Africa.

S3.15.2 Novelization: Countering Cultural Centralization and the Unitary Language of Science Education

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Wolff-Michael Roth, University of Victoria

ABSTRACT: Science educators are facing challenges in accommodating an increasing cultural diversity in science classes that results from globalization. Despite a substantial body of literature on the issue, little is known of the reasons for which common and mundane science curricula are so resistant to cultural diversity. In response, we propose a new way of thinking about and investigating these problems. Following contemporary perspectives on cultural representation and signifying, we understand science education as a practice where particular cultural images of science are represented. Drawing on cases from our ongoing ethnographic research on representation practices in science education, we show that even the most mundane, common and daily representation practices in science classrooms maintain a unitary language leading to cultural centralization. That is, the very nature of science – to be valid in the same way in every

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place, at every time, in every context – and of the education into this science opposes the desire to cultural diversity. Specifically, in these practices forms of time and space are posited such that the resulting representations are epics that mitigate valuing and keeping cultural diversity in science education. Accordingly, we propose to rethink of science curricula as constituting the novelization of representation practices of science. Such practices allow for a continuous genre-in-the-making in science curricula capable of appropriating increasing cultural diversity. The implications of this proposal are discussed.

S3.15.3 Teaching Science for Democratic Reconstruction in Rural South Africa

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

ABSTRACT: This research explores science teaching that is situated in the social, historical, and political context of post-apartheid South Africa. In classrooms where rote learning and corporal punishment had been the norm, a revised outcomes-based science curriculum now calls for learner-centered classrooms that promote active engagement and the development of critical and creative thinking. In addition, new language policies promote English as the language of instruction among teachers and students whose first language is isiZulu. These factor are among many that are currently shaping the development of science education in South Africa and the learning opportunities of students in rural KwaZulu Natal, but the transition to these new forms has not progressed smoothly. Cases studies of two Zulu, pre-service, science teachers reveal strategies that they use to create new classroom interaction patterns that contrast with a history of passive students and authoritative teachers. Through these examples, the paper explores what democratic science education might mean in a post-colonial context, such as post-apartheid South Africa, and considers the extent to which definitions of democratic education and transformative science can and should be universal.

S3.15.4 The Multiple Voices of Agency: Multilingual Science Classrooms for Pre-service Science Teachers

Lizette Ramos, Universitat Autònoma de Barcelona, silvializette.ramos@uab.cat

Mariona Espinet, Universitat Autònoma de Barcelona

ABSTRACT: Most European science classrooms are at present constituted as multilingual learning communities where two or three languages are used as resources for meaning making. The CLIL (Content and Language Integrated Learning) approach is being extended in basic and higher education institutions adding new educational demands on science teachers and science teacher educators. This paper explores the use of this approach for the promotion of pre-service science teachers' participations in the acquisition of new discipline-specific knowledge (Science) and new communicative competences (learning English). Using a sociocultural perspective we explore how the students expand their agency in the use of resources (material and human) as a way to overcome the difficulties derived from the necessity to construct a scientific explanation of natural phenomena using English as foreign language. We present a microanalysis of the small group interactions during an experimental activity. We identify that actions as classification of objects and use of gestures and pauses, adding to the unequal distribution of social and cultural capital are ways of participation that promote a collaborative work and afford success. CLIL contexts for pre-service science teachers are educative settings that promote agency and in consequence their cultural productions are diverse.

Strand 12: Educational Technology

S3.16 Attitudes, Perceptions and Beliefs Influencing Educational Technology

8:30am – 10:00am, Bonaire 3

Presider: Yilmaz Kara, Karadeniz Technical University

S3.16.1 Employing Pedagogical Design Principles for Initiating Distance Learning: STEM Students' Attitudes and Preferences

Rania Farraj, Technion-Israel institute of Technology, rania1r2@technion.ac.il

Miri Barak, Technion-Israel Institute of Technology

Yehudit Judy Dori, Technion-Israel Institute of Technology

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ABSTRACT: We present an exploratory study that investigated the feasibility of establishing a graduate distance education program in science, technology, engineering, and mathematics (STEM). We examined STEM graduate students' attitudes and preferences regarding online distance learning (DL). Data collected from an attitude questionnaire revealed that only 40% of the participants had experienced DL, but 70% were interested in attending DL courses. Content analysis of students' responses to open-ended questions indicated that flexibility in time and place, facing new challenges, enabling independence, and enhancing professionalism were the primary reasons for future enrolment in a DL course. Lack of communication with instructors, lack of self-discipline, desire to separate learning from daily life, and worrying about not being able to understand the learning material were the leading reasons for avoiding DL adoption. We found that saving/managing time was a recurrent theme amongst DL proponents, while lack of personal communication was a major concern among DL opponents. Data indicated no statistically significant differences between gender and age groups. However, we found differences between participants with a post-modern perception of learning and those who believe in traditional teacher-centered education. STEM graduate students' attitudes, preferences, and pedagogical design principles are the guidelines of tailoring the DL courses.

S3.16.2 Innovative Information and Communication Technology Systems to Facilitate Student Learning: A Smart University Classroom in Taiwan

Chia-Li Debra Chen, National Taiwan Normal University, debra@ntnu.edu.tw

Yueh-Hsia Chang, National Taiwan Normal University

Chun-Yen Chang, National Taiwan Normal University

ABSTRACT: This chapter provides an overview of an ongoing research project, namely Center for excellence in e-Learning Sciences (CeELs), which aims to renovate the current science learning environment in Taiwan by establishing a Smart University Classroom using innovative Information and Communication Technologies (ICT). Based on the results in a previously conducted baseline study, several smart classroom technology systems have been suggested by the students and the instructor to meet their learning/teaching needs. Of which, two systems, Speech Driven PPT (SD_PPT) and Technology Enabled Interaction System (TEIS), have been developed and pilot tested. The results of the pilot test showed that in general, students' perceptions towards the two systems in facilitating their learning are fairly positive. Students, in particular, showed significant improvement in how they viewed learning with the use of ICT, both learning motivation and effectiveness with ICT, after experiencing the system.

S3.16.3 Modeling of Student Perceptions of Learning in Connected Science Classrooms: How to Facilitate Learner-Centered Environments

Soon C. Lee, The Ohio State University, lee.3552@osu.edu

Karen E. Irving, The Ohio State University

Douglas T. Owens, The Ohio State University

Stephen J. Pape, University of Florida

Melissa L. Shirley, University of Louisville

ABSTRACT: Science teachers strive to create learner-centered classroom environments that address both learning and self-engagement by encouraging students to take on productive ways of learning. Learning goals can be achieved by active collaboration between the teacher and students by fostering metacognitive and teachers' awareness of learning. Recent research studies with connected classroom technology (CCT) have explored ways to support science teachers to enhance learner-centered approaches in their teaching practice. In science classrooms with CCT, learner-centered environments can be facilitated with two features: (1) teachers' awareness of students' learning (TA), and (2) students' metacognitive awareness about their learning (SM). The technology-facilitated communication provides a variety of information not only for the teachers but also for the students. The results presented here are based on student focus group (SFG) interviews and survey data conducted as part of a larger research project Classroom Connectivity in Promoting Mathematics and Science Achievement (CCMS). Preliminary data analysis indicates that students report metacognitive awareness about their learning in connected science classrooms as well as teachers' increased awareness of their understanding. This result provides teachers information about how students view the connected classroom and how teachers can better facilitate learner-centered science classrooms with the technology.

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S3.16.4 Examining Students' Online Searching Strategies and Searching Patterns in Terms of Different Scientific Epistemological Beliefs

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Huei-Tse Hou, National Taiwan University of Science and Technology, Taiwan

Meng-Jung Tsai, National Taiwan University of Science and Technology, Taiwan

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

ABSTRACT: The purpose of this study was to examine how students of different levels of scientific epistemological beliefs (SEBs) might influence their online searching strategies and behaviors. Based on the measurement of a SEB survey, 42 undergraduate and graduate students were recruited and divided into sophisticated and naïve SEB groups in terms of their SEB scores. Additional data were collected through a self-reported instrument and screen capture of the students' searching processes. The instrument, Online Information Searching Strategies Inventory (OISSI), consists of seven scales that explore the students' online searching strategies. The recorded data were analyzed by sequential analysis to visualize the searching patterns. The results showed that students with more sophisticated SEBs tended to employ more advanced online searching strategies and to demonstrate a more metacognitively searching pattern.

Strand 13: History, Philosophy, and Sociology of Science

S3.17 Argument and Socio-scientific Issues

8:30am – 10:00am, Bonaire 4

Presider: Renee Schwartz, Western Michigan University

S3.17.1 On the Functional Roles of Science in Socio-scientific Discussions

Jan Alexis Nielsen, University of Southern Denmark, jan@imada.sdu.dk

ABSTRACT: The purpose of this paper is (a) to introduce to science education research a new analytical framework for understanding students' argumentation in socio-scientific discussions; and (b) to present results from an application of that framework in an empirical investigation of categorically different functions that articulated science contents can play in such discussions. The paper presents a framework that discloses the dynamic argumentative interaction among students, through a focus on dialogical processes rather than procedures for monological performance of argumentative acts. The empirical qualitative investigation was conducted as a case study in which 9 groups of 4-5 Danish upper secondary school biology students discussed (for 40-60 minutes) to which extent gene therapy should be allowed as a treatment of humans. A qualitative approach of critical-dialectical realism was applied for analyzing the transcriptions of the discussions. It was found that there are several different functions that science content can play, and that there are functions of science beyond explaining or defining phenomena. Science could be used more subtly and strategically - e.g. as devices for parties to naturalize or justify a set of values that they have. In the presentation categorically different functions and examples will be presented.

S3.17.2 Currents in STSE Education: Mapping a Complex Field, Forty Years On

Erminia G. Pedretti, University of Toronto, erminia.pedretti@utoronto.ca

Joanne Nazir, Ontario Institute for Studies in Education, University of Toronto

ABSTRACT: It has been forty years since STSE education first appeared in science education research and practice. Although supported amongst many educators worldwide, there is much confusion surrounding the STSE slogan. Widely differing discourses on STSE education and diverse ways of practicing, have led to an array of distinct pedagogical approaches, programs and methods. We are left wondering how we might orient ourselves amidst such a diversity of propositions. What does STSE look like in practice? What ideological orientations underpin its practice? In this paper, we review the research literature and educational practices in STSE education in order to: 1) map out a typology of STSE education in the form of currents, and 2) provide a heuristic that educators can use for critical analysis of discourses and practices in the field. We identify, explore and critique six currents in STSE education: application/design, historical, logical reasoning, value centered, socio-cultural, and socio-ecojjustice currents. We suggest that these currents may

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serve as a didactic tool for others, a framework that will assist educators in informing their own theoretical understandings, choices and practices in the context of STSE education.

S3.17.3 Using Socioscientific Issues to Enhance Reflective Judgment in High School Students

Brendan E. Callahan, Ferris State University, brendancallahan@ferris.edu

Dana L. Zeidler, University of South Florida

Jeffrey Orasky, University of South Florida

Bryan H. Nichols, University of South Florida

Karey Burek, University of South Florida

ABSTRACT: The purpose of this study was to investigate the relationship between a semester-long Socioscientific Issues (SSI) curriculum and reflective judgment in high school Biology I students. The SSI movement combines social issues with a moral or ethical component with scientific relevance. Characteristics include open-endedness, controversial nature, and the use of moral or ethical reasoning. Reflective judgment (RJ) is an epistemological construct designed to examine how people conceptualize and acquire knowledge. Both SSI and RJ depend on the use of evidence to support decisions. This quasi-experimental design utilized mixed-methodology in order to study reflective judgment. Although the study did not result in statistical significance, the reflective judgment scores of the treatment group increased over six months at a rate higher than predicted over four years of high school. Qualitative data indicates there are specific instances in which students progressed from pre-reflective to quasi-reflective thought. Although this was a small sample and the findings require further investigation, there is the potential for the development of reflective judgment in high school students through the use of an SSI curriculum.

S3.17.4 Argument and Explanation: A Necessary Distinction?

Alexis D. Patterson, Stanford University, alexisdp@stanford.edu

Jonathan F. Osborne, Stanford University

ABSTRACT: This paper is an attempt to address an emergent confusion in the literature and policy documents between the concept of an argument and the concept of an explanation. During the past two decades the potential role of argument in formal science education for learning has been a significant focus of research in science education. Some of the focus of this work has been not on argument per se but rather on student's ability to construct explanations (McNeill, Lizotte, Krajcik, & Marx, 2006; McNeill & Krajcik, 2008; Sandoval, 2003). Drawing on an examination of these and other papers, it is our contention that there exists a conflation of the words 'explanation' and 'argument'. Whilst, we recognize that the distinction between the terms might seem subtle to the reader, our intention is to demonstrate that it is not only significant but also important. Moreover, the failure to distinguish between these two concepts is a weakness in the field. For, if a field lacks clarity about the concept that it seeks to explore and promote as a feature of classroom practice, then it will fail to communicate its meaning and intent to the wider audience of curriculum developers, standards developers and teachers.

Strand 14: Environmental Education

S3.18 Expanding EE Understanding Through Technology and Assessment

8:30am – 10:00am, Bonaire 5

President: Carol B. Brandt, Virginia Polytechnic Institute and State University

S3.18.1 Assessing the Effect of Systems Simulations on Systems Understanding in Undergraduate Environmental Science Courses

Heather J. Skaza, University of Nevada-Las Vegas, hjskaza@hotmail.com

Krystyna A. Stave, University of Nevada-Las Vegas

Kent J. Crippen, University of Nevada-Las Vegas

ABSTRACT: This paper describes the results of a paired experiment testing the effect of system dynamics simulations on systems understanding in an undergraduate environmental science course. The performance of 189 students in four

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sections was measured at several points during the semester. Half of the students used computer-based system dynamics simulations in their assignments; the other half did not. Results of a regression analysis show that performance on systems questions immediately following the intervention was significantly better for the experimental group than the control. The study also highlighted problems in the assessment framework used and led to suggestions for improving both the systems interventions and the assessment tools. The application of a systems perspective and the computational systems simulations used as an intervention in this study exemplify a viable solution for achieving the goal of Global Sustainability and Improving the Public Understanding of Science.

S3.18.2 Investigating the Impact on Student Learning and Outdoor Science Interest through Modular Serious Educational Games

Elizabeth Folta, SUNY-College of Environmental Science and Forestry, wildlife.educator@gmail.com

Leonard A. Annetta, George Mason University

Rebecca Cheng, George Mason University

Richard Lamb, Campbell University

Shawn Y. Holmes, NC State University

ABSTRACT: In an effort to get children outdoors and exploring the natural environment, a Modular Serious Educational Game (mSEG), Red Wolf Caper (RWC), was created. RWC uses a combination of an augmented reality (AR) game and a serious educational game (SEG) to capture the students' interest in the natural world around them. The game is set around a mystery in which red wolves in eastern NC are being poisoned. Do mSEG affect students' understanding in environmental education concepts, specifically, collecting, and evaluating data collected in-game, knowledge of environmental systems, and social implications for the reintroduction of a species? The game was tested by 81 middle school students. They were given a 5-question pretest/ posttest related to the role they played; wildlife biologist, botanist, or entomologist. Students were asked to develop a hypothesis, provide evidence, and write a letter to a local judge explaining the importance of the reintroduction project. Sixty-nine completed pretests/posttests scores were analyzed using a paired t-test ($p = 0.000046$). The letters to the judge showed that participants understood scientific concepts and were able to apply them to real world settings. This study explores one possibility of how mSEGs can be used in education.

S3.18.3 An Examination of Nonformal Environmental Educators' Technology Use to Promote Earth and Environmental Science Learning

Tamara E. Pfeffer, Lehigh University, tep205@lehigh.edu

Alec M. Bodzin, Lehigh University

ABSTRACT: This study examined the use instructional and learning technologies by nonformal environmental education practitioners (NFEETs) to promote earth and environmental science learning. An internationally distributed 40-question survey was developed to inquire about NFEE demographics, technology use in practice, and beliefs about technology. The survey consisted of multiple choice, Likert-type and open-ended questions, and included the Technology Attitudes, Perception, and Support Scale (TAPS). TAPS was designed to examine pedagogical philosophies about technology use, self-efficacy, and perceived obstacles to technology integration within environmental education contexts. The survey was completed by 406 NFEETs. TAPS had a total score reliability (Cronbach alpha) of 0.809. Findings revealed a philosophical acceptance and willingness to use technology in NFEE instruction. However, while participants regularly utilize a variety of productively software, few integrate learning technologies into their instructional venues to enhance cognition and learning in the earth and environmental sciences. As a representative group, the 406 participating NFEETs indicated that they recognize the potential of technology to improve learning, reduce negative experiences, and build emotional ties to the environment.

S3.18.4 Longitudinal Analysis of Student Responses: Insights Gained Regarding Instrument Quality and Ecological Concept Development

Elsa Schaub, University of Arizona, eschaub@email.arizona.edu

Bruce Johnson, University of Arizona

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Sanlyn Buxner, University of Arizona

ABSTRACT: This study assessed the quality of six test items from the Ecological Concept Questionnaire (ECQ), an instrument consisting of multiple choice items that is used in the evaluation of environmental education programs. The study analyzed individual responses from 116 students who participated in a sequence of earth education programs, Earthkeepers and Sunship Earth, designed to help students build deep, integrated understandings of energy in natural systems. We examined patterns of student responses to individual test items over four different points in time, before and after both programs. We describe how crisscross diagrams, graphic representations of individual student answer responses to individual items across time, allowed us to uncover subtle but important issues with individual test items and helped us pinpoint influences of specific program activities on student understanding that could be easily overlooked if student answers were analyzed as a whole. The insights gained from this study contribute to the overall improvement of instruments currently in use to measure the impact of environmental learning programs and also of program activities to better support student understanding of energy concepts.

Awards Committee Sponsored Session

S4.1 Symposium – Setting out in Science Education Research

10:15am – 11:45am, Antigua 1

President: Xiufeng Liu, University at Buffalo, SUNY

Presenters:

Thomas R. Tretter, University of Louisville

Heather Toomey Zimmerman, Pennsylvania State University

ABSTRACT: In this symposium presentations will be made by two winners of NARST 2010 Awards. Heather Toomey Zimmerman, as winner of the Outstanding Doctoral Research Award, will reflect on the development of her doctoral dissertation 'Everyday science and science every day: Science-related talk and activities across settings' and outline the current direction of her research. Thomas R. Tretter, as winner of the Early Career Research Award, will outline his programme of work on nanoscale cognition and point to further research developments in this area. Both of these presentations will be of special interest and potential inspiration to those just setting out in science education research.

External Policy Committee & Strand 15: Policy Sponsored Session

S4.2 Symposium – The Development of New Science Standards Aligned with NRC's Framework

10:15am – 11:45am, Antigua 2

President: Sharon Lynch, George Washington University

Discussants:

Stephen Pruitt, Achieve

Joseph S. Krajcik, University of Michigan

Janice Earle, National Science Foundation

Francis Eberle, National Science Teachers Association

Andrew Shouse, University of Washington

Elizabeth A. Davis, University of Michigan

Sarah J. Carrier, North Carolina State University

Jerome M. Shaw, University of California Santa Cruz

ABSTRACT: The focus of this session will be on the efforts of Achieve to develop a new set of science standards that follow from the NRC's Framework for Science Education. Based in Washington, DC, Achieve is an independent, bipartisan, non-profit organization created in 1996 by the nation's governors and corporate leaders. Its goal is to help states raise academic standards and graduation requirements, improve assessments and strengthen accountability. Achieve was a critical partner in the development of the Common Core Standards and Assessments for mathematics and English/Language Arts. Achieve's efforts in creating the new science standards are funded by the Carnegie Foundation. When the NRC's Framework for Science Education has been finalized (possibly March, 2011), it falls to Achieve to take

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the lead in developing new science standards based upon the Framework. This symposium will describe the processes in place to develop the new set of science standards, focusing on how members of the NARST community might be involved. It will also provide discussion of the similarities and differences in the process for developing science standards compared to for the development of the Common Core State Standards and assessments for math and language arts. The speaker representing Achieve and its science standards effort is the Stephen Pruitt, who joined Achieve as the Director of Science in July of 2010. Stephen began his career as a high school Chemistry teacher in Georgia, later joining Georgia Department of Education as the Program Manager for Science, the Associate Superintendent of Assessment and Accountability, and the Chief of Staff to State School Superintendent Kathy Cox. Stephen has also served as President of the Council of State Science Supervisors, and as a member of the writing team for the College Board's Standards for College Success Science Standards. Most importantly for this symposium and the science standards development, Pruitt served on the National Academies of Science's Committee on Conceptual Framework for New Science Education Standards. Following Stephen's 45 minute talk on the progress and prognosis for a new set of science standards, there will be 45 minutes for discussant responses from Janice Earle, the National Science Foundation; Joe Krajcik, member of the NRC Science Framework Committee and the Achieve Science Standards group, and Francis Eberle, Executive Director of NSTA, who will discuss the policy implications of standards for science teachers, schools and state school systems, as well the implications and new directions for the science education research community.

Strand 1: Science Learning, Understanding and Conceptual Change

S4.3 Scientific Reasoning in the Life Sciences

10:15am – 11:45am, Curacao 1

Presider: Deborah C. Smith, The Pennsylvania State University

S4.3.1 Models as Epistemic Anchors: How Model-based Inquiry Can Create Epistemic Demand

Julia Svoboda, Georgia Institute of Technology, jsvoboda3@gatech.edu

Cynthia Passmore, University of California, Davis

ABSTRACT: We investigated how model-based inquiry (MBI) could potentially create opportunities for students to experience epistemic demand. We took a descriptive approach, relying on empirical examples to explore what epistemically demanding tasks looked like for students. The context of this work was the Collaborative Learning at the Interface of Mathematics and Biology (CLIMB) program, an NSF-sponsored traineeship for undergraduate biology and mathematics majors that introduced them to mathematical modeling in biology. Using field notes, transcribed video, written task instructions, and student-authored documents from six different instructional modules, we described empirical examples that highlighted differences in epistemic demand. The examples we chose contrast model-anchored tasks, in which student activity was explicitly linked to the ideas in the scientific model and model-decoupled tasks, in which the model itself was not at the center of the activity. These contrasts provide a detailed look at what it looks like for a task to support epistemic demand and identifies missed opportunities in tasks that do not. Our results suggest that the potential of MBI to create epistemic demand depends upon helping instructors develop relevant tasks as well as preparing students with the strategies they need to take responsibility for generating and evaluating scientific knowledge.

S4.3.2 Helping Students Learn More Expert Framing of Complex Causal Dynamics in Ecosystems Using EcoMUVE

Tina A. Grotzer, Harvard Graduate School of Education, Tina_Grotzer@pz.harvard.edu

Shane Tutwiler, Harvard Graduate School of Education

Amy Kamarainen, Harvard Graduate School of Education

Shari Metcalf, Harvard Graduate School of Education

Chris Dede, Harvard Graduate School of Education

ABSTRACT: Research suggests that students make a different set of assumptions about the nature of the complex causal dynamics and systemic structure than ecosystems scientists do when reasoning about ecosystems dynamics (e.g. Grotzer & Basca, 2003; Hmelo-Silver, Pfeffer, & Malhotra, 2003). For instance, students are likely to assume that causes

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and effects behave in an event-like fashion, to act locally and within an abbreviated time span, and to assume intentional actors as the causal entity. Seventh and eighth graders' ($n = 69$) causal assumptions were tested early and late in the learning process as they worked with a Multi-user Virtual Environment (MUVE) called EcoMUVE designed to simulate ecosystems patterns and structural causalities. The affordances designed into the EcoMUVE enabled students to test their initial causal assumptions and to realize their limited explanatory power for solving an ecological problem posed within the virtual environment. Students' later reasoning revealed shifts towards more expert framing of ecosystems causal dynamics for some of the ecosystems features such as action at a distance.

S4.3.3 Supporting Students in Developing Explanatory Models of Natural Selection

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

ABSTRACT: The difficulties in teaching students about natural selection have been well documented. Helping learners develop more sophisticated models of natural selection requires supporting them in building an evidence-based explanation for each of the steps in the natural selection process (pre-existing variation, changing environmental conditions, differential survival, passing on traits). We describe a study of classroom enactments of a project-based unit that helps students develop this model through a series of data-based investigations of population change. The unit builds on the students' prior experience in developing explanatory models to fit data as part of the Investigating and Questioning our World Through Science and Technology (IQWST) curriculum series. Each case includes data on population variation, survival value of traits, changing environmental conditions, and heritability of traits. The first case concerns the increase and decrease of the carbonaria variant of the Peppered Moth with changing pollution levels. The second case involves explaining differential survival within a population of Galápagos Finches, using software tools to access and analyze data. Students then draw on the explanations of these two cases and develop a more general model of population change to be applied to new cases. We will present studies of this natural selection unit in three 8th grade classrooms that examine the explanatory models students developed in classroom activities, their explanations for the moth and finch population changes, and written assessments of their understanding of natural selection.

S4.3.4 Under the Microscope: A Study of Lab-based Instruction in Biology

Gillian Puttick, TERC, gilly_puttick@terc.edu

Brian Drayton, TERC

Meaghan Donovan, TERC

ABSTRACT: We report results from a study on research on life-science laboratory experiences in the English-language, peer-reviewed literature. The study focused on the extent to which research addressed student learning about the characteristics of living systems and the growth of students' biological reasoning. We examined research methodology, biological subject matter addressed, and materials and methods used in the lab. We also sought to establish some estimate of the degree of student inquiry that the lab allowed. This paper will focus on findings on: i) the basic characteristics of the corpus, ii) the biological domain addressed, iii) the degree of inquiry, pedagogical design and activity structure, and iv) student outcomes. The literature on biological lab experiences is not rich, and there is no warrant yet for a coherent approach to use of labs to encourage biological reasoning. We hope to stimulate a conversation about the role, value, and design of laboratory experiences that will strengthen our students' understanding of the processes of life. We will discuss the balance between the conceptual backbone of the life-science curriculum and the values of an inquiry approach, as well as the pedagogical setting that mediates the way students engage in these activities.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S4.4 English Language Learners in the Science Classroom

10:15am – 11:45am, Curacao 2

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

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S4.4.1 The Use of Evaluative Questions to Shift ELL Student Engagement in a Secondary Science Classroom

Traci S. Baizer, University of Washington, tracibaizer@hotmail.com

ABSTRACT: An action research study was conducted in a secondary school with a focus on a sheltered science classroom. Drawing on the constructs of the sociocultural theory, this study examines how a shift in engagement can alter the participant structure for all students in a classroom discourse. English Language Learners (ELLs) who may experience greater demands to participate in whole-class discussion are less likely to stay engaged and experience a deeper understanding of science concepts. This research suggests that a shift in student engagement can be fostered amongst all students through the use of student-generated evaluative questions. A shift in participation during this research produced evidence of (a) ELL students helping each other make sense of the science concepts through the use of their own languages (b) all students pressing each other for further justification and (c) better communication of ideas and reasoning during a whole-class discussion. This study illustrates how a linguistically-scaffolded classroom discourse activity can be used to help all students better understand how to draw on evidence to justify their scientific responses during discourse.

S4.4.2 Changing Perceptions about Science for Underrepresented Students through an Authentic Inquiry-based Investigation

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

Barbara A. Crawford, Cornell University

ABSTRACT: This study investigates how the context of authentic investigation may alter and shape underrepresented students' views about science. This research follows the implementation of the Fossil Finders project in an urban middle school classroom serving English language learning (ELL) students from Latino backgrounds. Following participation in an authentic investigation and interaction with a scientist, students demonstrated views about science as 1) more than just a subject at school, 2) different than media-based examples of "mad scientists" in white lab-coats, and 3) more specific to the discipline of geology. Students also demonstrated self-identifying as scientists to a greater extent and greater interest in pursuing scientific careers. The changes in student perspectives coming out of the intersection between students' school-worlds of science and the practices of actual science illustrate the need to bridge between these disparate spaces and to create learning opportunities that facilitate students in doing so. The instructional approach used by the Fossil Finders poises initiatives that seek to draw together school, science, and students' everyday understandings as promising for engaging underrepresented students in science.

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

S4.5 Understanding Student Ideas

10:15am – 11:45am, Curacao 3

Presider: Suna Ryu, UCLA

S4.5.1 Preschool Children's Views about Science and Scientists: Findings from an Innovative Research Instrument

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

ABSTRACT: What do young children think about science? What stereotypes do they hold about scientists? When do these views develop? These fundamental questions in the field of science education have rarely been studied with the population of preschool children. One main reason is the lack of an appropriate research instrument that addresses preschool children's developmental capabilities. The current study presents the development of a pioneering research tool, developed for studying young children. This tool, in the form of a computer 'game', does not require reading, writing or expressive language skills and is operated solely by the child. The program engages children in several simple tasks involving picture recognition, and yes/no answers in order to reveal their views about science and scientists. The article describes the instrument's components, methods of analysis and findings of pilot and large scale studies, suggesting that children as young as 4 years old possess an emerging concept of science. The findings also suggest that the instrument successfully detects differences in choice's pattern among dissimilar groups of children grouped by

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gender, age or classroom. Findings from this interdisciplinary study will contribute to the fields of early childhood research, science education research, program evaluation and early childhood curriculum development.

S4.5.2 Understanding Elementary Students Knowledge of Health and Wellness

Ann W. Wright, Canisius College, wrighta@canisius.edu

Sue Tunnicliffe, University of London

ABSTRACT: Six activities have been developed to address two general curricular problems. One problem is the lack of integrated human biology curricula and the second problem is health advocacy. Each activity includes first, subject knowledge, which comes from the basic science facts in the main body of the lesson, second, inquiry acquisition, asking questions, analyzing a situation or finding out what problems there are, thirdly, subject related communication, this will be communicating with others. The topics present the context in language appropriate for the student. The assessments include a diagnostic assessments which determine the students prior knowledge, formative assessments that determine what the students are learning as they work through the activity, and a summative assessment. The study has led to insights in particular practices of instruction using activities that not only teach human biology (Connolly, 1998; Onwuegbuzie & Leech, 2004) but also teach health, wellness, inquiry skills, and process skills. As observed by Nastasi and Schensul (2005), qualitative research is essential for providing the initial evidence necessary for application of connection to real-life situations and for identifying core components which are related to required outcomes.

S4.5.3 An Exploration of Upper Elementary Students' Storyboarded Conceptions of Magnetism

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

John C. Bedward, North Carolina State University

Eric N. Wiebe, North Carolina State University

Lauren Madden, Science Education North Carolina State University

Mike Carter, North Carolina State University

Zebetta King, Swift Creek Elementary School

ABSTRACT: To help combat the proliferation of "reasoning thin" elementary science curricula, exploratory work is being done around the use of student storyboarding (sequenced graphical representations and text) as a tool to promote the deep learning of elementary school science. This research paper reports upon a small-scale design-based research study being conducted to build local theory around ways to orchestrate upper elementary students' "conceptual encounters" with magnetism. Using a mixed-methods approach, we systematically placed student work along a surface to deep learning continuum that included five levels of sophistication ordered in terms of various characteristics including the movement from the concrete to the abstract, the use of an increasing number of organizing aspects, increasing consistency, and the relating and extending of key principles. Second level analysis generated more nuanced data regarding students' meaning making using graphics and text. In this analysis we looked at several dimensions of interest including evidence of student metacognition, conceptual moves between the abstract and the concrete, and changes in students' private theories as a result of the experience found between frames (both in writings and drawings). The results and discussion will highlight the critical connections among students' conceptions, abstract reasoning with text and graphics, and pedagogy.

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

S4.6 New Programs and Resources for Middle and High School Science Teaching

10:15am – 11:45am, Curacao 4

President: N. Sanjay Rebello, Kansas State University

S4.6.1 Analysis of Teaching Resources for Implementing an Interdisciplinary Approach in the K-12 Classroom

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

Soonhye Park, University of Iowa

ABSTRACT: Articles from the National Science Teacher Association (NSTA) publications during the past five years were analyzed to investigate the characteristics of resources available for teachers who want to implement interdisciplinary

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approaches into the science classroom. Articles were coded based on the discipline incorporated as well as the teaching tools provided so teachers can implement the lessons in their own classrooms. Of the articles read, approximately 13% of Science & Children, 21% of Science Scope, and 17% of The Science Teacher articles met the interdisciplinary approach criteria. Student t-tests were used to analyze the statistical significance between using multiple disciplines in the science classroom. Results show that overall, reading, writing, art, and technology are the subjects most commonly integrated into science. Surprisingly, math is rarely discussed across all school levels. The articles most frequently provided resources, such as books, as teaching tools; followed by lesson plans, general strategy, and real-classroom examples. Comparing the articles across different school levels, Science Scope articles have the highest number and most integrated articles, whereas The Science Teacher had the fewest and least integrated articles.

S4.6.2 Identifying and Replicating Successful Teacher Practices in Urban Science Education

Christopher Emdin, Teachers College, Columbia University, ce2165@columbia.edu

ABSTRACT: This paper provides a framework for successful secondary school teacher practices in urban science classrooms by focusing on the practices of six teachers. By implementing tools for identifying successful practices, and uncovering ways that these practices could be identified and replicated, the research suggests that successful teaching can be supported in urban science classrooms.

S4.6.3 Teachers' Implementation of Digital Media and Inquiry Teaching Strategies Following Online Professional Development

Lauren B. Goldenberg, Education Development Center, lgoldenberg@edc.org

Scott Strother, Education Development Center

Alice Anderson, Education Development Center

Camille Ferguson, Education Development Center

Marian Pasquale, Education Development Center

ABSTRACT: This descriptive case study project examined the teaching practices of eight high school biology teachers during their genetics and evolution units. The teachers participated in a larger research study on the impact of an online professional development course that focuses on using digital resources and inquiry strategies to teaching genetics and evolution. We used a range of data sources to answer the following questions: (1) How did the teachers use digital media during their genetics and evolution units to enhance student engagement and learning? (2) What pedagogical strategies from the course did teachers use during their genetics and evolution units? We interviewed each teacher three times over the course of the school year; conducted one site visit that included observations and student focus groups; and collected artifacts using the Scoop Notebook process (Borko, Stecher & Kuffner, 2006). Preliminary findings indicate that teachers find inquiry strategies very difficult to incorporate into their teaching practice; they reported using more digital resources due to the course; the main use of digital resources was as a supplement to lectures on genetics and evolution topics; school culture and state policies worked against implementing any change in practice.

S4.6.4 Accelerating Achievement in Math and Science in Gifted Urban Students (AAMSUS): A Project-based; Guided Inquiry Program and the Nature of Science

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

Toni A. Sondergeld, The University of Toledo

Laurence J. Coleman, The University of Toledo

ABSTRACT: This study investigates whether AAMSUS, a federally funded Javits grant focused on enriching gifted urban middle grade students' math and science skills, fostered the development of deeper understandings of the nature of science (NOS) in its students. Our research was guided by this question: Does the science component of AAMSUS, designed to provide NOS experiences (implicit) and instruction (explicit), influence students' views of the nature of science? A greater number of informed views were found at the end of AAMSUS program than at the beginning, for seven of the eight VNOS-C categories: Empirical, Tentative, Creative, Inferential, and Scientific Method NOS aspects. However, more Informed Views for the Theory Laden NOS dropped slightly from the pre-test to the post-test. This research can, in part, provide valuable insight for classroom teachers to use to guide their future science instruction by

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identifying and distinguishing the NOS concepts that students find less complicated to comprehend and the NOS concepts that students find more challenging to comprehend.

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

S4.7 Developing Scientific Research Skills in Undergraduates

10:15am – 11:45am, Curacao 5

President: Leila Amiri, University of South Florida

S4.7.1 The Impact of the Owens Ready Bridge on Student Preparation, Interest, and Confidence

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

Staadén Moira Van, Bowling Green State University

Anne Bullerjahn, Owens Community College

ABSTRACT: In its third year of NSF funding the Owens Ready Bridge (ORB), part of the SETGO (Science, Engineering, and Technology Gateway of Ohio), is an important collaboration between 2 and 4 year institutions of higher education. The SETGO program includes a three-tier approach to increasing the total number of students entering and matriculating through STEM degree programs. The focus of this research is on the ORB which provides an interdisciplinary approach including field trips to assist graduating high school students or transfer students in preparing for the rigors of academic study at a four-year institution in STEM disciplines. The ORB consists of a supportive, small-group, hands-on, integrated laboratory and classroom instruction for 10 hours each week. Findings suggest that students feel more confident not only in their preparation for the rigors of a STEM degree, but also in their decisions to complete the degree. Participants cite the small group learning environment, faculty and peer mentoring, as well as integrative learning activities and field trips as reasons for their increased confidence. The data also shows that the ORB program has been successful at exceeding graduation rates from the 2-year institution as well as transferring into STEM degree's at the four-year institutions

S4.7.2 Undergraduate Science Research and the Nature of Science: Is Opening the Door to Understanding Enough?

Lara B. Pacifici, Kennesaw State University, lpacifici@kennesaw.edu

ABSTRACT: Undergraduate research in science has greatly increased over the past two decades. Scholarly research has highlighted benefits, such as increased research skills and understanding of the development of scientific knowledge, gained by students through undergraduate science research. While students who do undergraduate research are well-prepared to grapple with questions on the nature of science when prompted to critically think about their ideas about science, the purpose of this study was to explore whether the experience of doing research is enough for students to grasp the nature of science. Interviews with undergraduate science majors were analyzed using methods gleaned from Grounded Theory. Through their experiences in the lab or the field, students realized that a general and universal method for research may not exist and that evidence accumulated carefully in research may not result in sure knowledge, but instead of realizing that what they experienced in their research reflects the nature of science and research, students perceived their research experiences as distinct from objective science. Encouraging students to explicitly reflect on how their experiences with science research relate to the overall nature of science may be a way to bridge the gap between the nature of science and science research experiences.

S4.7.3 A Comparison of Two-year and Four-year College Students' Undergraduate Research Experiences

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

Roger House, William Rainey Harper College

William J.F. Hunter, Illinois State University

Gregory Ferrence, 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

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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. The Survey of Undergraduate Research Experiences (SURE) was administered at the end of both summer and academic year experiences throughout the project. Aggregated means show that as the program progressed, students engaged in the 2YC collaborative showed greater gains than their 4YC counterparts in all areas measured by the SURE by the fourth year of the program.

S4.7.4 Improving Undergraduate Life Science Students' Rhetorical Consciousness of Research Articles

Lacum Edwin B. Van, University of Groningen, e.b.van.lacum@rug.nl

Martin J. Goedhart, University of Groningen

Miriam A. Ossevoort, University of Groningen

ABSTRACT: The ability to successfully read and comprehend a research article (primary literature) is a skill every science student in higher education has to master. Therefore, we have developed a teaching strategy which aims to teach undergraduate life science students how to read primary literature. To achieve this, we made use of genre analysis: students will be better readers if you make them conscious of the different textual elements (rhetorical moves) in a research article. The teaching strategy was implemented in a 10-week course. Our research questions were: 1) What is the actual progress of students in their ability for identifying rhetorical moves in research articles during the course? 2) What remaining difficulties do students mention at the end of the course? By using a pre-test, post-test and questionnaires we measured the effects of the course. Our analysis of the data suggests that our teaching strategy is a successful method to improve undergraduate students' rhetorical consciousness. Students were more able to identify the rhetorical moves in a research article and they also could do it in less time. Further research should reveal if our teaching strategy can be used in different disciplines like chemistry and physics.

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

S4.8 Strategies for Improving Student Learning in Biology

10:15am – 11:45am, Bonaire 7

President: Toth Eva Erdosne, West Virginia University

S4.8.1 Explaining the Visible with the Invisible: Students' Conceptual Representations of the Genetic Origin of Variation

Speth Elena Bray, Saint Louis University, espeth@slu.edu

Matthew Dirnbeck, Saint Louis University

Paul Le, Saint Louis University

Jennifer L. Momsen, North Dakota State University

Tammy M. Long, Michigan State University

Sara A. Wyse, Bethel University

ABSTRACT: Introductory biology students traditionally acquire fragmented and compartmentalized information, presented as a linear sequence of facts with few or no connections among them. In the context of a reformed introductory biology course on genetics, evolution and ecology, we aimed at promoting an integrated way of learning biology. The overarching goal was that our students would understand how the information contained in genes is reflected in organisms' traits, and how these traits determine the reproductive success of individuals in different environments ultimately influencing population composition and, in the long term, leading to evolution. We aimed to develop: (a) a pedagogy that would promote this kind of learning, and (b) a method to assess whether students could reason about biological systems and represent their knowledge in an interconnected way. Structure-Behavior-Function (SBF), an ontology widely used to describe models of complex systems, guided our development of pedagogy and assessment. We present one example of how student-generated SBF models can inform us about their understanding of a particularly difficult concept in biology, the genetic origin of variation among individuals in a population.

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S4.8.2 A Mental Mobile: Using Branch Rotation to Solve the Puzzle, Are these Trees the Same?

Jill D. Maroo, University of Southern Mississippi, Jill.Maroo@eagles.usm.edu

Kristy L. Halverson, University of Southern Mississippi

ABSTRACT: Phylogenetic trees are often thought of as mobiles, with branches swiveling around nodes. However, these trees are normally drawn as two dimensional diagrams, causing branch rotation to take place on a mental level, through mental rotation. The purpose of this study was to explore possible links between phylogenetic tree reading and spatial ability through the lens of mental rotation. We analyzed 56 student pre/post responses on a mental rotation test and a tree thinking test. We found a significant relationship between student performance on mental rotation and tree comparison tasks that prevailed throughout the semester, unrelated to gender. However, mental rotation cannot be used a predictor of student success in developing tree thinking skills because, after instruction, student scores increased on both tree interpretation and comparison questions regardless of their mental rotation ability. So although students with higher mental rotations may grasp comparing phylogenetic trees quicker, all students learn tree thinking and use this thought process to solve the puzzle, "Are these trees the same?"

S4.8.3 Microevolution and Macroevolution: Ne'er the Twain Shall Meet?

Kefyn M. Catley, Western Carolina University, kcatley@wcu.edu

Laura R. Novick, Vanderbilt University

ABSTRACT: Evolution encompasses a broad range of processes from variation in the genome of organisms to cladogenesis and extinction of higher taxa. Whereas learners' conceptual problems understanding microevolutionary processes (i.e., natural selection) have been well studied, only recently has research been conducted to document issues of understanding surrounding macroevolution. This paper addresses a critical and as yet untested connection between students' knowledge of natural selection concepts and competence at tree thinking (a measure of understanding macroevolution). College students (N =124) participated in a study in which half of the students received instruction in tree thinking and half did not. All students completed both the Conceptual Inventory of Natural Selection (CINS) (a test of understanding of natural selection i.e., microevolution) and an assessment of skill at tree thinking (a test of understanding of a significant part of macroevolution). Both instruction in tree thinking and prior knowledge of microevolution were associated with better performance on the tree-thinking assessment. We believe this is the first critical test of the relationship between knowledge of micro- and macroevolution. We argue for a paradigm shift in evolution education such that curricula visualize evolution as a broad hierarchical continuum integrating the processes of natural selection with those of macroevolution.

S4.8.4 Understanding Evolution and Evidentiary Support

Carrie J. Boyce, University of Southern Mississippi, carrie.boyce@eagles.usm.edu

Kristy L. Halverson, University of Southern Mississippi

ABSTRACT: Scientists are expected to provide evidentiary support to mold, strengthen, alter, and refute ideas. Systematic biologists explore how organisms are related through their evolutionary histories by collecting different types of informative evidence. However, students often struggle with understanding science content and evidence selection when considering evolutionary relatedness. The purpose of this study was to explore how upper-level biology students made sense of evolution and used evidentiary support with their understandings. Using a mixed methods approach, we gathered data from 120 upper-level life-science majors. We found a statistically significant relationship between evidence used to support evolutionary relationships and the accuracy of students' understandings of evolution. However, we found that students who provided scientific explanations of evolution did not always use informative evidence to support their understandings; this suggests that these students did not recognize meaningful patterns that highlight appropriate evidence. Findings from this study can be used by instructors to develop a curriculum that helps explain the evolutionary theory and the evidence required for support.

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Strand 6: Science Learning in Informal Contexts

S4.9 Museums as an Extension of the Classroom: Lessons Learned

10:15am – 11:45am, Curacao 6

S4.9.1 A Conceptual Framework for Designing Educational Museum Experiences

Marianne F. Mortensen, University of Copenhagen, Denmark, mm@ind.ku.dk

ABSTRACT: Research on museum learning indicates a shortcoming in exhibit design: that interactive exhibits, while often successful in prompting visitors to carry out intended actions, do not necessarily prompt the intended interpretations of these actions. This shortcoming is operationalised in terms of the notion of praxeology from didactics research, leading to two recommendations regarding the design of educational exhibits: using praxeology in its capacity as a model of human activity and the features that precipitate this activity, and using didactic transposition to guide the process of creating an exhibit on the basis of a praxeology. These uses of the notions are exemplified, and their significance discussed on two levels: that of exhibit design, and that of research into exhibit design.

S4.9.2 Investigating different kinds of learning from interactive science exhibits

Leonie J. Rennie, Curtin University, l.rennie@curtin.edu.au

Rosemary S. Evans, Curtin University

ABSTRACT: This study investigated students' use of two interactive science exhibits to answer two questions: First, did students understand how to use the exhibit to obtain the intended outcome and did they know what concept the exhibit was designed to demonstrate? Second, did students understand the science principles behind the construction of the exhibit? These questions reflect two different meanings of the phrase "understanding a science exhibit". One concerns whether or not interacting with the exhibit results in its intended outcome and the other concerns understanding how the exhibit actually works. Research took place in four elementary schools where interactive science exhibits were on loan from a science center. The two exhibits were a Stereoscope which used light, mirrors and lenses in the normal way, and a Steadiness Tester which demonstrated hand-eye coordination and was constructed using an electric circuit. Observations of, and interviews with, 151 students revealed that although nearly all students could use the exhibits, few could explain the concept they were demonstrating. However, most had some idea of the scientific principles behind how they worked. Teachers can make valuable use of exhibits to help students learn science concepts apart from those the exhibits are built to demonstrate.

S4.9.3 Understanding Teacher Intentions for Field Trips to a Museum of Natural History

Peggy L. Preusch, Smithsonian National Museum of Natural History, ppreusch422@gmail.com

ABSTRACT: Visits to museums create learning experiences beyond the traditional classroom setting. The Smithsonian National Museum of Natural History (NMNH) is a popular field trip choice for many K-12 class field trips. This mixed method, qualitative and quantitative, research study explores the intentions of teachers for their students' educational experience during field trips to the NMNH. A survey was emailed to field trip contacts at schools throughout the U.S. Questions included school, teacher, and student demographics, and open-ended questions about teacher preparation for the field trip, learning goals, and continuity with classroom science lessons. Teacher interest and prior experiences in science were used to develop an understanding of their individual identity. Survey responses revealed a pattern of greater complexity of preparation and continuity with classroom subject matter where teachers collaborated with each other, with museum staff, or with additional contexts relevant to museum exhibits. Collaboration within schools and with the museum community thus may play a larger role in development of more effective museum field trip designs than has been fully recognized. Although teacher identity is recognized as an important element in effective teaching, more studies are needed of identity in relationship to science teaching and field trips in particular.

S4.9.4 The Medium is the Message: Unraveling the Publics' Responses to Body Worlds

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Michelle Dubek, OISE, University of Toronto

Susan Jagger, OISE, University of Toronto

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ABSTRACT: Body Worlds (which showcases human bodies that have undergone a process of plastination) is an example of a controversial science centre exhibition, and provides the context for this study. Specifically, we sought to understand why this exhibition is so controversial, and how publics - visitors, museum staff, etc. - make meaning of their experiences. This qualitative case study draws on multiple data: 1) visitors' written comments - over 20,000; 2) taped interviews (with 51 visitors, 6 staff, and 10 with visitors who chose not to attend); 3) field notes and 4) content analysis of the exhibition, media releases, and pamphlets. Public responses reflect the following themes: celebration of human life; commodification of death; health and education; and beauty. Tensions include: appropriateness of the exhibition; the question of whether it is art or science; and dissonance. This research contributes to the literature on visitor meaning-making, and the changing roles of science centres. We attempt to shed light on how controversial exhibitions play out in the public sphere, and suggest that care, balance and sensitivity to public agendas must be carefully considered. Finally, we discuss what constitutes a science centre exhibition, and the role that "event-culture" plays in the promotion and development of exhibitions.

Strand 7: Pre-service Science Teacher Education

S4.10 Preparing Teachers for Diverse Schools

10:15am – 11:45am, Curacao 7

President: Gail Richmond, Michigan State University

S4.10.1 Attributes that Shape Science and Math Preservice Teachers' Commitment to Teach in Under-resourced Schools

Athena R. Ganchorre, University of Arizona, athenag@u.arizona.edu

Debra Tomanek, The University of Arizona

ABSTRACT: This investigation of secondary pre-service science and mathematics teachers revealed three attributes that shape their commitment to teach in under-resourced schools and districts: motivations, beliefs and emerging roles of identities. Qualitative methods were employed, that elicited 15 pre-service teachers' motivations to teach are grounded in a disposition of compassion and empathy. Pre-service teachers have complex understandings of children and adults who live in low-income or poor communities that form their beliefs about students' learning opportunities and parent-school relationships. Early childhood experiences negotiating home, school and public spaces shaped one Latino pre-service teachers' emerging professional roles of identities. Attributes associated with motivations, beliefs and roles of identities play an important role in pre-service teachers' career placement choices. This study supports the importance of recruiting prospective science and mathematics teachers who have knowledge of and a disposition to work with learners from low income or poor communities. Further, teacher preparation programs must examine ways to aid, support and develop skills, knowledge and interests of potential teachers in training who show deep commitment to teach and serve students from diverse socio-cultural and linguistic backgrounds.

S4.10.2 Cultural Bumps: An International Cross-cultural Strategy used with Preservice Science Teachers during Field Placement

Shawn Y. Holmes, North Carolina State University, shawn_holmes@ncsu.edu

Jamila S. Simpson, North Carolina State University

ABSTRACT: This study focuses on the implementation of an intercultural relations strategy known as culture bump analysis to encourage the self-reflection of preservice science teachers regarding their own cultural values during their field placement experience. Culture bump analysis, a strategy created by Archer (1991), is a process utilized to foster self-awareness in individuals with the hope of moving participants from seeing others as "foreign" to self-awareness and cross-cultural understanding. Fourteen preservice science teachers enrolled in a Masters of Arts in Teaching (MAT) course at a large university in the Southeast participated in the study. Qualitative analysis of students' written reflections and in-class discussions revealed that most preservice teachers were originally unaware of their own cultural frameworks and how they may influence their classroom experience. However, the preservice teachers viewed the cultural bump analysis as a catalyst for self-reflection and central for the increase of their self-awareness of their

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personal cultural framework. Most preservice teachers began the study with judgmental perspectives towards individuals with whom they had a culture bump. By the end of the study they had moved to acknowledging their own personal cultural values and ultimately accepting a broader understanding of culture in hopes of becoming a better science educator.

S4.10.3 Readiness for Diverse Environments: Measuring Pre-service Science Teachers' Confidence about Teaching in High-Need Schools

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

Jacqueline T. McDonnough, Virginia Commonwealth University

Kevin D. Goff, College of William & Mary

Kathryn E. Ottolini, College of William & Mary

Colleen P. Riesbeck, College of William & Mary

ABSTRACT: This pilot study tracks a group of pre-service science teachers through changes in self-efficacy and outcome expectancy about teaching in high-need schools as they progress toward licensure. Instruments used were the STEBI (Enochs & Riggs, 1990) and the CRTSE and CRTOE (Siwatu, 2006). Self-efficacy and outcome expectancy for teaching science and teaching in a culturally responsive manner were measured in eight pre-service science teachers (PSTs). Interviews were conducted and used for triangulation. Statistically significant gains were seen in self-efficacy in both self-efficacy instruments at the end of the first semester of the teacher education program, no gains were seen following student teaching. Interview results indicated that students gained during student teaching. Ceiling effects were possible for the CRTSE, but not for the STEBI. Conclusions include the positive impact of the first semester of the teacher education program, on both science teaching and on teaching in a culturally responsive manner. Also noted was the lack of change during student teaching, seen in the surveys but not in the interviews. .

S4.10.4 Investigating Changes in Preservice Secondary Science Teachers' Conceptions About the Pedagogical Implications of Student Diversity

Douglas B. Larkin, Montclair State University, douglarkin01@gmail.com

ABSTRACT: This study explores the nature of the changes in thinking that occur in prospective teachers during teacher education programs, and in particular the pedagogical implications of student diversity within the teaching of high school science. The specific research question examined here is: How do preservice secondary science teachers' conceptions about what it means to teach science in diverse classrooms change during a teacher education program? The theory of conceptual change serves as the framework for understanding preservice teacher learning in this study, where the experiences of six prospective secondary science teachers from four different teacher education programs are described using a multiple case study approach. Qualitative data was collected from students through interviews, questionnaires, teaching portfolios, written coursework, lesson planning materials, and naturalistic observations of student teaching. Findings of this study include the fact that participants came to view the salience of diversity in science teaching primarily in terms of students' interest, motivation, and engagement. Also, it appeared prospective teachers needed to first recognize the role that student thinking plays in learning before being able to understand the pedagogical implications of student diversity became possible, a finding that resonates with the current emphasis on eliciting student knowledge in science education.

Strand 8: In-service Science Teacher Education

S4.11 Elementary Science Teachers

10:15am – 11:45am, Curacao 8

Presider: Irene U. Osioma, California State University, Dominguez Hills

S4.11.1 An Interpretive Case Study of how an Elementary Science Teacher uses Science Notebooks During Science Instruction

Lori L. Petty, University of Texas - Brownsville, lori.petty@utb.edu

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Ratna Narayan, Texas Tech University

ABSTRACT: This interpretive case study focused on an elementary science teacher's use of science notebooks as a first-time user during science instruction. Areas of emphasis were her thoughts about science notebooks, design of the notebook prompts, the rationale behind them, actual notebook usage during instruction, assessment, and feedback with regard to the notebook. The primary method of data collection used was two in-depth audio-taped interviews with the elementary science teacher. The findings address a tension between implementing a scripted curriculum and science notebook usage; using notebooks for organizational, not science learning purposes; and lack of teacher knowledge regarding specific science notebook strategies.

S4.11.2 From Professional Development to the Classroom: A Case Study of a 3rd Grade Teacher's Implementation of the Learning Cycle

Deepika Menon, University of Missouri, dm2qc@mail.mizzou.edu

Deborah Hanuscin, University of Missouri

ABSTRACT: Current reform efforts in science education focus on changing how science is being taught in classrooms, which requires an equal substantive change in professional development practices at all levels (NRC, 1996). A recent focus of professional development programs for elementary teachers is to help them understand the meaning and nature of inquiry and how to implement inquiry in their classrooms. The Quality Elementary Science Teaching (QUEST) professional development program is designed for K-6 classroom teachers to learn physical science content and instructional strategies for inquiry based teaching through the learning cycle. The purpose of this case study is to explore how a 3rd grade teacher incorporated the 5E learning cycle in his lessons to teach topics based on physical sciences. Data were collected over a four month period and included classroom observations and interviews. Analysis generated three assertions, or themes, which were supported in turn by the participants' voice across the multiple sources of data. These address participant's success and enthusiasm in incorporating the learning cycle in his classroom teaching but also the difficulties in implementing the model. Our findings point toward a need for enhanced classroom support following professional development.

S4.11.3 Rethinking Professional Development in Elementary Science: Teacher Leadership for Sustainable Change in Science Education

Milijana Suskavcevic, Rice University, milijana@rice.edu

Lisa Webber, Rice University

ABSTRACT: Professional development literature agrees on core elements that characterize strong professional development training programs for in-service teachers. Elementary model science lab follows the quality standards described in literature, but it also contains several unique features. One of these features is a leadership component embedded in the comprehensive, job-embedded teacher development program in elementary science. We utilize Danielson's framework for teacher leadership and empirically examine effects of teacher training on development of science teacher leadership skills. The modal responses of items from the Participant Leadership Survey reveal positive change from pre to post assessments among the group of treatment teachers (n=74). Additionally, teacher responses on low and high leadership skill constructs reveal statistically significant differences between treatment and comparison samples. The research on teacher leadership is one among several studies addressing effects of professional development training in elementary science on multiple outcome measures using the RCT design.

Strand 8: In-service Science Teacher Education

S4.12 Professional Development and Policy

10:15am – 11:45am, Bonaire 8

Presider: Mary Oliver, The University of Western Australia

S4.12.1 How Much Professional Development is Needed to Effect Positive Gains in K-6 Student Achievement

James A. Shymansky, University of Missouri-St. Louis, jshymansky@umsl.edu

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Tzu-Ling Wang, National Hsinchu University of Education

Leonard A. Annetta, George Mason University

Larry D. Yore, University of Victoria

Susan A. Everett, University of Michigan-Dearborn

ABSTRACT: This paper is a report of a study that examines the relationship between teacher participation in a multi-year, K-6 professional development (PD) effort and the “high stakes” science test scores of different student groups in 33 rural mid-west school districts in the United States. The PD program utilized regional summer workshops and distance delivery technologies to help teachers learn science concepts, inquiry teaching strategies, and how to adapt science inquiry lessons to teach and reinforce skills in the language arts. Regression analyses revealed a significant positive relationship between the PD hours experienced by teachers and student gains on high stakes test scores. But the analyses also suggest that primary grade teachers need less PD than upper grade teachers on instructional strategies where the focus is on the integration of language arts and science inquiry. The implications for funding and implementing PD projects are discussed.

S4.12.2 An Exploratory Study of the In-Service Professional Development Needs of Botswana Secondary School Agriculture Teachers: Implication for Policy and Practice.

Kgomotso Mabusa, University of Nottingham, UK, ttxkm11@nottingham.ac.uk

Leonard R. Newton, University of Nottingham, UK

ABSTRACT: This paper reports on exploratory case study research to identify the in-service professional development (IPD) needs of agricultural Science teachers in Botswana in the context of the recent national reforms of the coordination of teachers’ in-service training. A questionnaire was used to gather data from all the secondary agriculture teachers in the Central Region of Botswana (N =247). Identified categories of teachers’ IPD needs included those related to: Teaching Strategies; Subject Matter Aspects; and Personal Needs. The data revealed not only teachers’ views of their IPD needs but also demographic patterns that lead to recommendations for more targeted IPD activities. The study has also implications at regional and national levels in Botswana and therefore further work is recommended to address the issue so that agricultural science teachers’ IPD needs are better understood nationwide.

S4.12.3 Fostering Teacher Development to a Tetrahedral Orientation in the Teaching of Chemistry

Rick Wiebe, St. James-Assiniboia School Division, rwiebe@sjsd.net

Brian E. Lewthwaite, University of Manitoba

Harvey Peltz, River East Transcona School Division

ABSTRACT: This paper presents a summary 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.

Strand 10: Curriculum, Evaluation, and Assessment

S4.13 Conceptual Learning

10:15am – 11:45am, Bonaire 1

S4.13.1 Middle-schoolers' Learning about Photosynthesis and Cellular Respiration: A Mixed Methods Study

Kathryn F. Drago, University of Michigan, kdrago@umich.edu

ABSTRACT: Students in the United States are less scientifically literate than their international peers, and therefore, less able to make evidence-based decisions about domestic or world-wide science concerns. Science educators are hopeful

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that curriculum integrating strategies predictive of student achievement in international contexts will improve science literacy in the United States. In this mixed methods study, I report on a curriculum that incorporates two such strategies in its design—coherence and a focus on science ideas. In the first part of the study, I find that the curriculum helps students to build beginning understandings about photosynthesis and cellular respiration. Students move toward understanding the molecular nature of carbon-containing molecules and how they are transferred between organisms, but lack a robust network of knowledge. In the second part of the study, I find that the quantity of time that students spent on activities and the ability of the discussion to push students' understandings interact with their ability to form this network of knowledge about photosynthesis and cellular respiration. While these ideas are challenging, we must find ways to support teachers and students in improving their understandings of these concepts due to their critical role in energy and environmental matters.

S4.13.2 STEM Learning and Scientific Reasoning

Lei Bao, The Ohio State University Department of Physics and College of Teaching and Learning, bao.15@osu.edu

Jing Han, The Ohio State University

Kathy Koenig, Wright State University

Tianfang Cai, Beijing Jiaotong University

ABSTRACT: How do you create an inquisitive mind? As far as science education are concerned, simply accumulating knowledge isn't good enough. Our research has suggested that the teaching and learning of "content knowledge" in physics at traditional education settings have little effect on developing students' ability for scientific reasoning. The findings are based on a large scale assessment study with data collected from more than 5,000 incoming first-year university students of science and engineering in China and the United States. The results might be surprising: the Chinese students had a clear edge when it came to solving physics problems, but this advantage did not translate into a better scientific-reasoning ability — here they were at the same level as their US counterparts. What can we learn then from this study? Its results suggest that knowing facts does not, in itself, lead to good reasoning skills. As both (and, one might argue, particularly the latter) are needed for success in STEM careers, it seems that aspects of science teaching do need to be reconsidered and carefully researched. Results of further studies on how scientific reasoning is naturally developed in the current education settings and how such development might be improved will be discussed.

S4.13.3 Investigating Students' Understanding of Energy Transformation, Energy Transfer, and Conservation of Energy Using Standards-Based Assessment Items

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

George E. Deboer, AAAS / Project 2061

ABSTRACT: Standards-based multiple-choice assessment items were used to study middle school, high school, and university students' understanding of ideas about energy transformation, energy transfer, and conservation of energy. The student data are a result of a field test administered to 9722 middle school students and 5870 high school students in 46 states across the country and 176 students from a public university in the south central region of the US. Rasch modeling was used to estimate and compare the students' abilities and the item difficulties and distractor analysis was used to investigate the strength of the students' misconceptions at the different grade levels. A cross-sectional analysis was performed to examine the progression of understanding of energy from middle school to university and revealed an increase in understanding from seventh grade to ninth grade and from tenth grade to university students. The students had the most difficulty with items aligned to the idea about conservation of energy. The results from items aligned to the ideas about energy transfer by electromagnetic radiation and conservation of energy suggest that while many students know the general principles, fewer students are able to apply these principles to specific instances.

S4.13.4 Managing Threats to Validity in Experimental Tests of Education Interventions!! Data and Evidence from a Large, Cluster-Randomized Trial (CRT) of a High School Science Intervention

Stephen R. Getty, Biological Sciences Curriculum Study, SGetty@BSCS.org

Christopher D. Wilson, Biological Sciences Curriculum Study

Joseph A. Taylot, Biological Sciences Curriculum Study

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Susan M. Kowalski, Biological Sciences Curriculum Study

ABSTRACT: A key challenge for educational researchers is designing investigations where the efficacy of an intervention is tested rigorously. Interventions with random assignment or well-matched populations (quasi-experiments) can appear relatively straightforward to design and implement. However, a range of factors before, during, and after the intervention can become threat to validity, and thus threats to project success. This is especially true for large studies, or those with a longitudinal component. To manage such threat to validity, we report data and our experience from planning and conducting over 5 years a large cluster-randomized trial (CRT) of science curricula in high school. This CRT currently involves 15 districts, 23 schools, over 70 teachers, and about 4,500 grade 9 science students. With this research context, we address the question: What factors can help researchers manage and reduce threats to validity in tests of educational interventions? We show how workers can be aware of and reduce such threats to validity in their research.

Strand 11: Cultural, Social, and Gender Issues

S4.14 Gender, Socially, and Culturally Responsive Science Pedagogies: Bridging the Gaps between Students and Science

10:15am – 11:45am, Bonaire 2

Presenter: Irasema B. Ortega, Arizona State University

S4.14.1 The Case for Using Social and Emotional Learning to Enhance STEM Learning: Project STEMSEL

Obed Norman, Morgan State University, obednorman@verizon.net

Sylvester Mckay, Morgan State University

ABSTRACT: The presentation reports on a project investigating the effect of incorporating Social and Emotional Learning (SEL) into the K-12 STEM curriculum in schools and particularly in minority serving schools. SEL is aimed at teaching students to 'recognize and manage emotions, care about others, make good decisions, behave ethically and responsibly, develop positive relationships, and avoid negative behaviors. There is growing evidence that SEL does contribute to student academic success. Studies have also found that adolescents with school-focused possible selves are at reduced risk of involvement in delinquent activities and do better at school.). The STEMSEL Project goals and activities are captured in the overall project research question: Can a structured intervention aimed at fostering positive student academic attitudes be integrated with a quality inquiry science program to increase both student academic outcomes and positive achievement-oriented attitudes? Our approach is to present inquiry science teaching to teachers as a vehicle for realizing a fuller participation for minority students in science. We report on baseline data that clearly shows the need for incorporating SEL in STEM teaching. Ongoing data collection is aimed at investigating the impact of the project on student motivation and STEM achievement as well as on teacher practice.

S4.14.2 Descriptive Analysis of Gender-related Motivating Factors for Girls and Boys in High-needs Middle Schools

Eunmi Lee, DePaul University, yjsmom@gmail.com

ABSTRACT: In an effort to transform how math and science teachers are prepared to teach middle-grade girls from high-needs schools such that girls are better prepared and more inspired to pursue careers in science, technology, engineering, or mathematics, the purpose of this study is to examine ways in which gender equitable pedagogy at the middle school level in high-needs schools in the areas of math and science can be enhanced.

S4.14.3 Bridging the Gender Gap: Equality vs. Equity

Jaimie L. Miller, Harvard University, jlmiller@cfa.harvard.edu

Gerhard Sonnert, Harvard University

Zahra Hazari, Clemson University

Philip M. Sadler, Harvard University

ABSTRACT: The persisting gender gap in science participation and performance—even decades after the formal barriers against women in these fields had fallen—has caused “equity” strategies for closing the gap to gain ground vis-à-vis

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earlier “equality” strategies. This paper lays out the conceptual equality/equity framework and makes it the basis for its analysis of an open-ended survey in which 259 science teachers’ described their pedagogical techniques and approaches to narrowing the gender gap in their classrooms. We examine whether male and female teachers tend to follow different approaches, and, if so, whether these differences are aligned with the equality/equity framework. We find that there indeed exist gender differences among teachers, and that female teachers more strongly emphasize approaches that are connected to the equity principle.

S4.14.4 Development, Validation and Preliminary Use of the Culturally Congruent Instruction Survey

Regina C. Sievert, Salish Kootenai College, wenonah@centurytel.net

Joan LaFrance, Mekinak Consulting

Rod Brod, Professor Emeritus, the University of Montana

ABSTRACT: Scholars hypothesize that cultural incongruities between teachers and students hinder students’ learning. A small but growing number of research studies is providing evidence that indicates that improving the cultural congruency of instruction (CCI) increases diverse students’ achievement. This paper describes work in the development, validation and preliminary use of a teacher self report survey designed to assess the nature and frequency of teachers’ use of CCI in teaching science with K-8 American Indian students in Montana. The instrument is currently being used in a quasi experimental study to assess impacts of a NSF - MSP on teachers’ professional development in CCI. Changes found in teachers’ CCI to date and results of the factor analysis are described.

Strand 11: Cultural, Social, and Gender Issues

S4.15 Related Paper Set - Investigating Diverse Girls' Identities and Identity Trajectories in Science

10:15am – 11:45am, Bonaire 6

ABSTRACT: This symposium brings together five studies that examine the identity work that diverse girls from different racial, ethnic and SES backgrounds engage in science, both in and out of school. The five studies span elementary, middle and high school grades and utilize a range of methodologies including longitudinal case study, narrative inquiry and mixed methods approaches. The overarching questions for the session include: How do girls author themselves in science? What individual and community oriented factors and contexts shape girls’ identity trajectories in science, and how? What is the relationship between identity work and science learning? The five studies draw from a range of theoretical underpinnings including sociocultural perspectives of learning, practice theory, and narrative and discursive theories on identity. Findings highlight the importance of identity work performed by girls in the different figured worlds in which they engage with science. Figured-world specific factors (e.g. community members and resources) have direct bearing on the identity work performed by the girls and influence their science trajectories.

S4.15.1 Becoming (Less) Scientific in the Figured Worlds of School Science Learning: A Longitudinal Study of Girls’ Identities

Heidi B. Carlone, University of North Carolina

Julia Kimmel, University of North Carolina

Cassi Lowder, University of North Carolina

Jean Rockford, University of North Carolina

Catherine Scott, University of North Carolina

S4.15.2 Urban Girls’ Identity Trajectories through the Participation between Figured Worlds

Hosun Kang, Michigan State University

Angela M. Calabrese-Barton, Michigan State University

Edna Tan, Michigan State University

Juanita Bautista Guerra, Michigan State University

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S4.15.3 Girls and Science: Urban Middle School Girls' Perspectives, Positioning and Activism in Science when Conversations about Identity and Discrimination are Explicitly Nurtured

April Luehmann, University of Rochester

Rachel Chaffe, University of Rochester

S4.15.4 Out of School Figured Worlds and Urban Girls' Engagement with Science

Angela M. Calabrese-Barton, Michigan State University

Edna Tan, Michigan State University

Hosun Kang, Michigan State University

Juanita Bautista Guerra, Michigan State University

Strand 12: Educational Technology

S4.16 Examining the Effect of Traditional and Non-traditional Educational Technologies

10:15am – 11:45am, Bonaire 3

President: Miri Barak, Technion- Israel Institute of Technology

S4.16.1 Transforming and Enhancing the Learning and Teaching of Senior Biology via Digital Technologies

Wilhelmina S. Van Rooy, Macquarie University, Australia, wilhelmina.vanrooy@mq.edu.au

John Hedberg, Macquarie University, Australia

Peter Freebody, The University of Sydney, Australia

Kim Nichols, University of Queensland, Australia

ABSTRACT: The availability of digital technologies and their affordances for learning and teaching of any senior biology high school syllabus, now makes it realistic for curriculum developers to include some of the new areas of biological research particularly genetics in such documents. Digital technologies make it possible for emerging disciplinary knowledge and understandings previously too small, large, slow or fast to be taught. Indeed much of bioscience can now only be effectively taught via digital technology since its representational, symbolic forms are in digital formats. This paper part of a larger Australian study dealing with the technologies and modalities of learning biology in secondary schools compares and contrasts the classroom practice of three experienced biology teachers as they seamlessly integrate available digital technologies with a number of molecular genetics concepts. The data is qualitative and its analysis is based on video classroom observations and semi-structured teacher interviews. Findings indicate that if professional development opportunities are provided where the pedagogy of learning and teaching of both the relevant biology and its digital representations are available, then teachers see the immediate pedagogic benefit of using digital technologies for student learning in particular challenging genetic concepts.

S4.16.2 The effect of Computer Simulation on Students' Conceptual Understanding of Electric Circuits

Saed Sabah, saed_sabah@yahoo.com

ABSTRACT: The purpose of this study was to examine the effects of using and computer simulations on understanding electrical circuits and to understand how computer simulations enhance students' of electrical circuits. This study also identified what simulations features and characteristics that facilitate understanding electricity. Both of the quantitative and qualitative approaches were adopted in this study. This study used the explanatory design in which the researcher collected the quantitative data before the qualitative data. This study involved thirty participants who took Science I for Elementary Teachers course in the second semester (Spring) of 2009 /2010. The experimental group (n =15) outperformed the control group (n = 15) on the test of understanding the concepts of DC circuits, $M_{exp} = 13.13$, $SD_{exp} = 4.61$, $M_{control} = 9.13$, $SD_{control} = 3.52$. After completing the quantitative part of this study, four students were interviewed to understand how computer simulations promoted their understanding of DC circuits. This study identified some key features of simulations that were very helpful to students in understanding DC circuits. The present study introduced several implications for teachers, administrators, and science education researchers.

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S4.16.3 Student Learning in Science Simulations: Design Features That Promote Learning Gains

Michael Timms, WestEd, mtimms@wested.org

Kathleen Scalise, University of Oregon

Anita Moorjani, WestEd

Lakisha Clark, University of Oregon

Karen Holtermann, UC Berkeley (retired)

Shawn Irvin, University of Oregon

ABSTRACT: This research examines student learning in science-simulation software (free and commercial) available for grades 6–12 science courses. The study presented, funded by the National Science Foundation, has two objectives: a literature synthesis and a product review. The literature synthesis examines research findings on grade 6-12 student learning gains and losses using virtual laboratories and science-simulation software, based on a review of 79 relevant studies identified. Based on the synthesis, significant aspects of how such products influence student learning are identified. Research-based evidence concerning best practice strategies embedded in the instructional design of virtual lab and simulation products are discussed. Ten products are reviewed as case studies to determine in what ways and to what extent each implements the research-identified best practices. The overall goal was to consider where effective progress is being made in virtual lab and simulation products, and what directions future development of these products should take. The overall intent of the study is to inform science educators, teachers, administrators and policy makers using, buying and examining middle and high school instructional materials, in order to help them make decisions in the best interest of their students.

S4.16.4 Effectiveness of Computer Simulations in the Teaching/Learning of Physics

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Tesfaye Tilahun, Addis Ababa University

Tadesse Mesfin, Addis Ababa University

ABSTRACT: The effects of the use of computer simulations on third world undergraduate students' achievement in physics theoretical and practical lessons was studied by comparing results obtained from simulation supported lessons with results from traditional lessons. The study was conducted on 75 freshman physics majoring students and on 27 final year physics majoring education students in two independent phases. In the first, we conducted a study on physics theoretical lessons and in the second, on physics practical lessons. Two research designs, Double Pretest and Switching Replicates, were employed on phase one and phase two studies, respectively. The findings of the study reveal that experimental group students had statistically significant differences in their mean achievements over their counterparts, with effect size magnitudes of 0.86 in theoretical lessons and 0.57 in practical lessons. It is pointed out that, students learning experimental physics courses with computer simulation demonstrated a good grasp of concepts as compared to students learning in traditional laboratory lessons. It is also concluded that computer simulated experiments followed by real experimental activities or real experiments followed by computer simulated experiments did not show statistically significant difference on students manipulating skill of apparatus.

Strand 13: History, Philosophy, and Sociology of Science

S4.17 Changes in Students' Epistemologies

10:15am – 11:45am, Bonaire 4

President: Sibel Erduran, University of Bristol

S4.17.1 What Changes Undergraduate Students' Perception of the Tentative and Creative Nature of Science?

Nazan U. Bautista, Miami University, uludagn@muohio.edu

Elisabeth E. Schussler, University of Tennessee - Knoxville

Kimberly A. Haverkos, Miami University

Melanie A. Link-Perez, University of Oklahoma

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ABSTRACT: The purpose of this study was to investigate and propose explanations for differential shifts in undergraduate students' perceptions of the tentative and creative nature of scientific knowledge in a college biology laboratory. The laboratory course was delivered via an experimental design of inquiry and expository instruction with or without explicit / reflective (ER) nature of science (NOS) instruction in fall 2008. We investigated the VNOS-B survey responses of 201 undergraduate students for changes in their understanding of the tentative and creative NOS from pre- to post-semester. The analysis revealed that students in expository laboratory sections had higher gains in the tentative NOS than in inquiry laboratory sections, and ER was not a significant factor. On the other hand, students in ER sections had higher gains in the creative NOS than those in non-ER sections, and the format of the laboratory was not a significant factor. We propose that different aspects of NOS may benefit from different instructional environments in college laboratories.

S4.17.2 Views on the Nature of Science - Results from Large-scale Assessment of Students' Competencies

Kerstin Kremer, Justus-Liebig-University Giessen, Kerstin.H.Kremer@didaktik.bio.uni-giessen.de

Irene Neumann, Leibniz Institute for Science and Mathematics Education, Kiel

Hans E. Fischer, University of Duisburg-Essen

Jürgen Mayer, University of Kassel

ABSTRACT: The large-scale study on students' understanding of the nature of science at the end of middle-school addresses seven NOS dimensions that build on common theoretical conceptions of nature of science and epistemological beliefs: source, certainty, development, justification, and simplicity of scientific knowledge, purpose of science and creativity of scientists. About 6000 10th grade students filled in a questionnaire that contained 4-point Likert-scale items on beliefs about the nature of science, attitudes towards science and the learning of science as well as socio-scientific variables on their school types and cultural background. The reliability of the scales varies between .60 and .83. Students' mean rating on the seven NOS scales varies between 2.43 and 3.20; this shows students' tendency towards relativist-constructivist understandings of the nature of science.

S4.17.3 Practical Epistemologies of High School Students Participating in a Research Apprenticeship

Stephen R. Burgin, University of Florida, sburgin@ufl.edu

Troy D. Sadler, University of Florida

Rachael D. Griffin, University of Florida

ABSTRACT: The purpose of this report is to examine student understandings of scientific epistemologies (also known as nature of science understandings) in the context of a research apprenticeship. These scientific epistemologies are termed practical in that they are closely linked to the student's actual practice of scientific inquiry in the context of an authentic research experience through their apprenticeship. Six high school student participants of a residential summer research apprenticeship program at a major university in the southeastern United States were interviewed twice during their experience to elicit their perspectives regarding the nature of scientific knowledge. A phenomenological approach was used to analyze these interviews. Findings from this analysis technique revealed that the shared experience of a research apprenticeship resulted in some consensus understandings of science in practice for these six participants. These students described scientific knowledge as being developmental, valuable, formulaic and authoritative. Implications from this work included a need for this research apprenticeship program and others like it to explicitly address the diversity of scientific methods, different forms of scientific knowledge, and the tentative nature of scientific knowledge.

S4.17.4 Comparative Case Studies of the Development of Third Graders' Conceptions of Nature of Science: Student Understandings after a Year of Instruction

Valarie L. Akerson, Indiana University, vakerson@indiana.edu

Vanashri Nargund, Indiana University

Ingrid S. Weiland, Indiana University

Khemawaddee Pongsanon, Indiana University

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ABSTRACT: This study explored 24 third grade elementary students' conceptions of nature of science (NOS) over the course of an entire school year as they participated in explicit reflective science instruction. The VNOS-D was administered pre instruction, mid school year, and at the end of the school year to track growth in understanding over time. The Young Children's Views of Science was used to describe how students conversed about NOS among themselves. All science lessons were videotaped, student work collected, and a researcher log was maintained. Data were analyzed by a team who sorted the students into low, medium, and high achieving levels. Three representative students were selected as case studies to provide an in-depth picture of how instruction worked differentially and how understandings changed for the three levels of students. It was found that students improved their conceptions of NOS and were able to converse among each other using the NOS terminology they learned without prompting by the teacher. However, those who were at the higher achievement level could provide definitions for NOS terms and examples of where they are illustrated in science that were not provided by the teacher, whereas those at lower levels could not provide examples.

Strand 14: Environmental Education

S4.18 Exploring Environmental Literacy and Future Green Career Interest

10:15am – 11:45am, Bonaire 5

President: Deborah J. Tippins, University of Georgia

S4.18.1 Going Green: Exploring Career Decision Making of Canadian Youth

Oksana Bartosh, Directions Evidence and Policy Research, ksenia_brt@yahoo.com

Charles Ungerleider, Directions Evidence and Policy Research

Isabelle Eaton, Directions Evidence and Policy Research

Terri Thompson, Directions Evidence and Policy Research

ABSTRACT: Increased interest in environmental issues has stimulated Canada's environmental sector, creating new opportunities for green careers. However, the demand for skilled professionals in the environmental sector is growing faster than the pool of qualified candidates. In order to understand why young people do or do not choose green careers, it is important to understand the factors that influence their initial career choices. This qualitative study explores what factors influence career decision-making of youth in general and green careers in particular by conducting interviews with career education providers and /or environmental educational practitioners across Canada. Analysis indicates that when it comes to environmental career decision-making, emotional connections, personal values, and a sense of responsibility are the most influential factors. Results also suggest that students and their teachers might have a limited understanding of what constitutes an environmental career, the opportunities for green employment as well as the requirements for employment and career opportunities.

S4.18.2 Students Environmental Attitudes: Links With Interest in Environmental-Related Topics, Out-of-School Activities and the Future Job

Hebel Florence Le, IUFM Université Lyon 1/ICAR ENS Lyon, florence.le-hebel@ens-lyon.fr

Pascale Montpied, ICAR ENS Lyon

Valerie Fontanieu, INRP Lyon

ABSTRACT: The purpose of this study is to investigate the attitudes towards environment in the population of French students, 15 years old. We analyse the results of the questionnaire-based relevance of Science Education Project carried out in France in 2008 as a part of a wider international comparative study ROSE (Relevance of Science Education). The hierarchical ascendant classification of data from 2124 French students, led to three main classes, showing a high resonance, with the three main attitudes toward environment: egocentrism, anthropocentrism and ecocentrism. The findings reveal significant gender effect in these three classes. Our data suggest that there are links between the three different attitudes toward environment and students' level of interest in learning about specific environmental topics. More, we could relate the three classes to the practice frequency of some specific out-of-school activities linked to nature. Our results show also links between students' priorities in different dimensions of their future job and their

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attitudes toward environment. Ecocentric concerns are significantly related positively to Universalism and negatively to Power values.

S4.18.3 What Do Eighth Grade Students Know About Energy Resources?

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

ABSTRACT: This study investigated 8th grade students' understandings of energy resource and associated issues including energy acquisition, energy generation, storage and transport, and energy consumption and conservation. A 39 multiple-choice item energy knowledge instrument was developed that aligned to explicit learning goals from the AAAS Atlas of Scientific Literacy (2007) about energy resources and associated issues. The assessment was completed by 1,043 eighth grade students in both urban and suburban schools in two northeast cities in the USA. Total score reliability (Cronbach alpha) for the assessment was .776. Mean scores for the entire assessment indicated low conceptual energy knowledge of the 8th grade students. Subscale means revealed that student understandings of energy resource acquisition, energy generation, storage and transport, and energy consumption and conservation are not satisfactory. Distractor analysis identified many misunderstandings that 8th grade students hold with regards to energy resources. Findings revealed that students did not have a sound knowledge and understanding of (1) basic scientific energy resources facts, (2) issues related to energy sources and resources, (3) general trends in the USA energy resource supply and use, and (4) the impact energy resource development and use can have on society and the environment.

S4.18.4 Contours of Environmental Action in Science Education: A Critical Discourse Analysis of Middle Grade Science Textbooks

Ajay Sharma, University of Georgia, ajay@uga.edu

Cory Buxton, University of Georgia

ABSTRACT: Science education has a big role to play in preparing a scientifically literate citizenry that is capable of not only understanding the complex underlying causes of climate change, but is also able to make well informed and evidence based social and personal decisions to mitigate its effects. This is a study that explores how curriculum material in science may be contributing to students' understanding of the relationship between social and natural systems in advanced capitalist societies, and the role individuals play in such relationships. Based on the methodological framework of critical discourse analysis, the study focuses on understanding multimodal representations of environmental action in two 7th grade science textbooks that are used in a suburban middle school in the Southeastern United States. Data analysis indicates that environmental action is predominantly represented as (a) a matter of technological expertise, (b) local in scope and action, and (c) a matter of individual virtue. The paper discusses implications of these emergent themes for the role that curriculum materials can play in shaping students as current and future environmentally active citizens.

S4.18.5 Promoting Global Sustainability: How do Students View the Ocean after an Ocean Literacy-focused Curriculum Program?

Meghan E. Marrero, U.S. Satellite Laboratory, mmarrero@us-satellite.net

ABSTRACT: As the British Petroleum oil spill has taught us, when considering global sustainability, we cannot overlook the importance of the ocean. Unfortunately, ocean literacy in the United States is very poor, leading to a citizenship that is ill-prepared to respond to such catastrophic issues. This case study uses a variety of data sources (e.g., interviews, documents, questionnaires) and grounded theory analysis to examine coastal and inland students' views of the ocean following a semester or year-long engagement in an ocean literacy-focused curriculum program. Analysis revealed two major themes: systems thinking about the ocean, and personal connections to the ocean. Following studying the ocean in their classrooms, students began to make connections between physical, chemical, biological aspects of the marine environment, and to recognize that whether they were a few or thousands of miles from the coast, that they and their communities affect the ocean. These findings are promising in that suggest that student engagement in relatively short term program focused on the ocean may help students to begin developing ocean literacy, ultimately making them better global citizens.

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Awards Committee Sponsored Session

S5.1 Symposium - Distinguished Contributions in Research

1:15pm – 2:45pm, Antigua 1

Presider: Philip H. Scott, University of Leeds, UK.

Presenters:

Joseph S. Krajcik, University of Michigan

Reinders Duit, IPN, Leibniz Institute of Science Education, University of Kiel, Germany

ABSTRACT: In this symposium Reinders Duit and Jo Krajcik, the winners of the 2010 Distinguished Contributions in Research Award will each make a presentation in which they reflect on their own work in the context of what is happening in science education research internationally. In addition they will offer their thoughts on what the future might and should hold for science education research. This is an opportunity both to hear from two greatly respected international leaders in the field of science education and to pay respect to their achievements.

Strand 1: Science Learning, Understanding and Conceptual Change

S5.2 Developing and Using Graphs in the Physical Sciences

1:15pm – 2:45pm, Curacao 1

Presider: David Fortus, Department of Science Teaching

S5.2.1 Intuitive rules - a Suggestion for an Additional Explanation of Misconceptions in Reading and Forming Kinematic Graphs

Haim Eshach, Ben Gurion University of the Negev, heshach@gmail.com

ABSTRACT: The present theoretical article focuses on difficulties students have in reading and forming kinematic graphs. Although existing research extensively detailed such difficulties, there is still no theoretical framework to explaining them. Here I suggest the intuitive rules theory (Stavy & Tirosh, 1996) as such a theoretical framework. It is not argued that the intuitive rules theory has the power to explain all of the barriers students are confronted with when dealing with kinematic graphs, but rather that the theory sheds light on a significant portion of such difficulties and therefore should be taken into account when designing an effective learning environments. Two intuitive rules which are relevant here are the Same A–same B, and More A More B rules. It is discussed how the activation of these rules may explain the students' difficulties. For instance, I show that the activation of the Same A-Same B rule explains why students tend to interpret graphs as being a kind of a "picture" representing the object's physical path, or why students tend to associating the shape of a given graph with the shape of other entities' graphs. Examples are also provided and implication for education is thoroughly discussed.

S5.2.2 Using Eye-tracking to Examine Learning in a Multimedia Simulation: The Importance of Visual Transitions

Catherine E. Milne, New York University, cem4@nyu.edu

Jan Plass, New York University

Bruce Homer, Graduate Center, City University of New York

Trace Jordan

Paul O'Keefe, New York University

Ruth Schwartz, New York University

Yoo Kyung Chang, New York University

ABSTRACT: The present study investigated the question of how learners interact with an exploratory particulate model of the gas laws embedded in a multimedia simulation designed to introduce learners to a chemistry topic (i.e., gas laws). Using eye-tracking technology, we examined learner transitions between key model elements and the associated graph, and explored patterns in the interactions between prior knowledge, these transitions, and learner outcomes. Results showed that the amount of time participants looked at each element was not predictive of learner outcomes. Rather, an increased number of visual transitions between key model elements and the graph (as compared to fixations on specific elements of the simulation) were predictive of beneficial learning outcomes for both low and high prior knowledge

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learners. These results helped us to understand that encouraging students to integrate an explanatory model with its associated graph may be key for supporting students to learn relatively complex science concepts using interactive multimedia simulations.

S5.2.3 Assessing Students' Graphing Skills in a Context-Based Chemistry Module

Shirly Avargil, Technion, Israel Institute of Technology, shirly.avargil@gmail.com

Orit Herscovitz, Technion, Israel Institute of Technology; Ort Braude College

Yehudit Judy Dori, Technion, Israel Institute of Technology

ABSTRACT: Developing students' scientific literacy and higher order thinking skills was the framework for establishing a new curriculum for high school chemistry major students. In this framework we developed a new module, Taste of Chemistry. The module focuses on context-based chemistry, rich in variety of data representations of food substances and emphasizes scientific literacy and graphing skills. Our research goals were twofold: (a) determine the effect of learning in context-based and multiple representations environment on students' graphing skills; (b) characterize teacher's role in promoting these skills. Research participants included 370 students divided into two experimental groups who studied the unit and two comparison groups. The research tools were pre-post questionnaires. We found that the combination of moving across tables and graphs representations, in a context-based science learning environment, improved experimental students' graphing skills compared with students who studied in traditional learning environment. Furthermore, teachers who provided their students with embedded assignments and encouraged them to develop graphing skills their students performed better in both constructing graph and drawing conclusions sub-skills. Our findings show that there is a need to emphasize graphing skills which are trans boundaries of science disciplines and important for developing scientific understanding.

S5.2.4 Characterizing Students' Use of Graphs in Introductory Physics with a Graphical Analysis Epistemic Game

Elizabeth Gire, University of Memphis, egire@memphis.edu

Dong-Hai Nguyen, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: We use the framework of epistemic games to characterize students' use of graphs to solve physics problems and the hints given by an instructor to facilitate the students' problem solving. We describe interviews with 20 university-level students enrolled in a first semester calculus-based introductory physics course in which individual students solved a problem that provided information in the form of a graph. We introduce the epistemic game Graphical Analysis and characterize and describe the solutions and interactions between the student and interviewer in terms of the moves of the Graphical Analysis game. We discuss the level of student facility with the moves of the Graphical Analysis game, describe various hinting strategies employed by the interviewer, and comment of their effectiveness in helping students use graphs more effectively to solve physics problems.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S5.3 Science Learning: Focusing on Student Communication and Dialogue

1:15pm – 2:45pm, Curacao 2

President: Bruce Waldrup, Monash University

S5.3.1 How does the Complexity of Students' Communication Influence the Learning Outcome?

Rebecca Knobloch, University of Duisburg-Essen, rebecca.knobloch@uni-due.de

Maik Walpuski, University of Osnabrueck

ABSTRACT: The aim of the study is to investigate the influence of the quality of content-related statements in small-groups on the learning outcome. Thereto, a reanalysis of existing video data of a preceding research project on experimental inquiry tasks in chemistry education was conducted. Based on this analysis the instructions were revised in order to achieve a higher grade of communication from a subject-specific viewpoint. The learning effectiveness of the revised instructions was examined in an intervention study by use of subject-specific achievement tests. The

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intervention study is going to last five lessons in the 7th grade of German secondary schools (Gymnasium). Shifting in communication processes are observed by conducting a category-based video analysis of the speech behaviour. Furthermore, the received video data will be compared to the already existing video data of the preceding project with regard to the processes and the learning outcome. To exclude epochal effects, the data of the control group are raised again. In this paper the results of the reanalysis of the video data and first results of the intervention study will be presented.

S5.3.2 Mixed Analysis of Student Relations Using Network Physics and Communities of Practice

Jesper Bruun, University of Copenhagen, Department of Science Education, jbruun@ind.ku.dk

ABSTRACT: The aim of this pilot study is to combine the methods developed to analyze the physical properties of networks with what is suggested by research in social theories of learning on the nature of student relationships. Students in an upper secondary class were asked to name, who they did collaborations with in school physics during the preceding week. Also, students were asked to write descriptions of the nature of their relation. The naming data was used to generate networks of subject relevant interactions between students, and a computer algorithm used to identify groups of collaboration. The written descriptions were used to design categories for elaborations on the nature of the named relations. These categories were developed using the framework of communities of practice (CoP). The goal was to integrate the quantitative approach of network representations with qualitative social learning theory in order to shed light on the dynamics of student subject relevant relations in the context of school physics. The results are to be used in a larger study of how students learn physics at different levels of the educational system.

S5.3.3 Towards an Interlanguage of Talking Science - Exploring Scientific Literacy through Analysis of Students Talk

Clas Olander, University of Gothenburg, Sweden, clas.olander@gu.se

ABSTRACT: Learning science involves appropriation of the school science language and this paper explore the intersection between social languages (colloquial and scientific), and epistemological and conceptual aspects of reasoning about biological evolution. Data was generated through videotaped peer group discussions; discussions that served both as an arena for learning and as a research tool. On this arena, the students are offered opportunities of communicating, valuing and arguing knowledge claims. The analysis focuses how words (especially Vygotsky's meaning and sense of words) and semantic patterns manifest in students' talk. The students frequently make contextual shifting between colloquial and scientific languages, resulting in a hybrid language; an interlanguage. Specifications of ideas are made step by step in negotiations, and the student groups talk more and more in line with scientific language. This is understood to rely on the establishment of an arena where technical terms and scientific models may be introduced, negotiated, and made sense of, in particular in relation to personal and everyday experiences where colloquial expressions serve as a resource in sense-making. Thus, interlanguage is a candidate for analysis and promotion of scientific literacy and public understanding of science.

S5.3.4 An Analysis of Whole-class Dialogue after Elementary Science Students Present their Claim and Evidence

Matthew J. Benus, The University of Iowa, matthew-benus@uiowa.edu

Yarker B. Morgan, The University of Iowa

Brian M. Hand, The University of Iowa

Lori A. Norton-Meier, University of Louisville

ABSTRACT: Our study sought to analyze the whole-class dialogue in elementary science classrooms that have implemented argument-based inquiry approaches. The analysis for this study involved examining a segment of classroom time beginning after small group presentation of claim and evidence ended and whole-class conversation about the presentation began. The segment ended when the discussion moved on to a new topic or a new presenting group. The framework for this analysis of this whole-class dialogue developed through an iterative process that was first informed by previous analysis, review of other instruments, and notable anomalies of difference from this data set. We then obtained Reform Teaching Observation Protocol (RTOP) scores for each of the classrooms. Our analysis shows that elements of whole-class dialogue in argument-based inquiry classrooms are different across different levels of RTOP implementation. Overall, low level RTOP implementation has a question and answer format that rarely includes

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discourse around scientific reasoning and justification. Higher levels of implementation are more likely to be focused on student use of scientific evidence to anchor and develop a scientific understanding of "big ideas" in science.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S5.4 Symposium - Socio-scientific Issues in Science Classrooms: Teaching, Learning and Research

1:15pm – 2:45pm, Bonaire 8

Presenters:

Troy D. Sadler, University of Florida, tsadler@coe.ufl.edu

Michelle L. Klosterman, Wake Forest University

Dana L. Zeidler, University of South Florida

Scott Applebaum, University of South Florida

Maria P. Evagorou, University of Nicosia, Cyprus

Shirley S. Simon, Institute of Education London

Ruth Amos, Institute of Education London

Jennifer L. Eastwood, University of Florida

Revital Tal, Technion - Israel Institute of Technology

Yael Kali, Technion - Israel Institute of Technology

Vaile Dawson, Curtin University

ABSTRACT: This symposium will provide a forum for the discussion of six classroom based socio-scientific issues (SSI) projects. Exploration of these projects will create opportunities to discuss pedagogies for teaching with SSI and student learning in the context of SSI as well as advances and challenges to the research being conducted around these issues. Leading scholars in the area of SSI education will present classroom based research projects conducted in four different countries spanning various science content disciplines and grade bands. Audience members will be introduced briefly to all six of the projects and then have opportunities to discuss two project in depth within small group settings. These small group interactions will be followed by a panel discussion in which themes that emerge across the projects will be addressed. The aims of the symposium are to 1) showcase classroom based research related to science teaching and learning in the context of SSI; 2) provide a forum for raising issues and challenges associated with conducting SSI research across diverse, international setting; 3) facilitate discussion among presenters and audience members regarding the state of SSI teaching and research; and 4) identify strategies for advancing the SSI agenda.

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

S5.5 Related Paper Set - Promoting and Examining Teacher Attention to Student Thinking in Science Classrooms

1:15pm – 2:45pm, Curacao 3

Presider: Rosemary S. Russ, Northwestern University

ABSTRACT: Teaching science in today's reform environment requires carefully attending to the substance of students' ideas so that those ideas can become the basis for meaning-making in the classroom. Unfortunately, despite the fact that both education researchers and teacher educators agree on the importance of teachers' noticing and responding to their students' thinking, research has shown that it can be difficult for teachers to do so consistently during instruction. Thus reform initiatives have called upon the science education community to develop supports for teachers' efforts in attending closely to their students' ideas. In this paper set we examine some basic questions about the character of science teacher attention to student thinking – what successful attention might look like, where refinement might be necessary, and where differences among teachers might exist. We do so with the assumption that building a research base on science teachers' attention will be crucial for designing effective teacher education supports. In addition we describe the success of some existing supports that use video of classroom instruction to promote science

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teacher attention to student ideas. The papers draw on different theoretical perspectives and methodological approaches, each with the intent of understanding a different aspect of this important pedagogical practice.

S5.5.1 Resolving Underspecification: Using Teachers' Existing Strategies to Refine the Meaning of Attending to Student Thinking

Valerie Otero, University of Colorado at Boulder

S5.5.2 Teacher Attention Leading to Student Inquiry: Case Study of an Emergent 5th Grade Magnetism Unit

Colleen Gillespie, University of Maryland, College Park

S5.5.3 Promoting Generative Inquiry: The Importance of Attention and Responsiveness to Multiple Aspects of Classroom Activity

Lama Jaber, University of Maryland, College Park

Jennifer Richards, University of Maryland, College Park

Luke Conlin, University of Maryland, College Park

David Hammer, Tufts University

S5.5.4 Supporting Elementary Teachers Learning to See Students' Thinking in the Science Classroom

Melissa J. Luna, Northwestern University

S5.5.5 Testing a Conceptual Framework for Science Teacher Learning Programs: The Student Thinking Lens

Kathleen Roth, BSCS

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

S5.6 Images of Science in the Classroom

1:15pm – 2:45pm, Curacao 4

Presider: Todd Milford, University of Victoria

S5.6.1 Images of Science in School Curriculum

Seema Rivera, SUNY Albany, SR681696@albany.edu

ABSTRACT: This investigation looks at the images presented in science curricula, to examine what types of images students see as representations of science. In the past, discourse analysis has been used to study books used in the classroom-- this research is attempting to push beyond just text, and look at the images that students see that are representative of science. In addition, images of how scientists are represented in textbooks have been looked at in this past, and have shown that students form stereotypes of scientists based on what they see in curricula. This exploratory study analyzed images in a popular high school science magazine, ChemMatters, from a qualitative perspective, to see what kinds of images were being presented to students, and how this could possibly affect their understanding of science or the scientific enterprise. The researcher placed the images studied on a continuum--one end that represented images created to engage students, while the other end of the continuum represented images created to inform students. It was found, from the six selected articles, that the magazine showed a balance between both engaging and informing images.

S5.6.2 Best Practice in Middle School Science

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

Kristen C. Wilcox, State University of New York at Albany

Janet Angelis, State University of New York at Albany

Arthur N. Applebee, State University of New York at Albany

Vincent Amodeo, State University of New York at Albany

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Michele A. Snyder, State University of New York at Albany

ABSTRACT: Using socio-ecological theory, this study explores best practice (educational practices correlated to higher student performance) in middle school science. Ten schools in NY were identified through regression analyses taking into account socioeconomic and demographic factors along with student performance on science assessments. Interview, observation, and documentary evidence from seven schools with consistently higher student performance were compared with three demographically similar, yet average performing schools. Best practice in middle school science included instructional approaches that emphasized (1) relevance and fun, (2) hands-on inquiry, (3) differentiated instruction, (4) collaborative work, (5) moderate amounts of homework and review, and (6) integration of language literacy and science, as well as administrative practices such as (7) nurturing a climate of fair opportunity to succeed in science, (8) offering professional development to improve science teaching through the use of data use and dialogue, (9) engaging teachers in standard-based curriculum revision and alignment, and (10) ensuring a good fit among administrators, educators and students. It is argued that best practice in science is not discrete teaching strategies adopted in individual classrooms isolated from the rest of the school, but rather multiple instructional and administrative practices that together form a school-wide socio-ecological system conducive to higher performance.

S5.6.3 Developing an Operational Model of Inquiry-Based Teaching: Teacher Roles and Pedagogies

Gillian Kidman, Queensland University of Technology, Australia, g.kidman@qut.edu.au

ABSTRACT: This paper aims to explore how teachers prepare to teach Australia's National Curriculum in science. One of the unique aspects of this curriculum is the emphasis on practical work and inquiry-based learning. Students build their scientific understanding and investigative skills through scientific inquiry where they make connections between their prior knowledge and with new ideas and evidence – but what role does the teacher play in this? A two-fold rationale drove this research study. First, there was the goal of examining the international literature relating to inquiry classrooms, and to use this literature to form a theoretical operational model. Second, the theoretical operational model was then examined and modified based on actual classroom observations and teacher interviews. Specifically, this study developed (from published literature) and refined (from classroom observations and teacher interviews) an operational model based on teaching and learning via guided and open inquiry-based pedagogies. The paper explores the following research questions: 1. What was the range of inquiry-based pedagogies employed by the teachers? 2. What were the differences between the teachers in their choice of inquiry-based pedagogies? and 3. What was the influence of student age on the choice of inquiry-based pedagogy?

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

S5.7 Symposium - Climate Education: Research, Perspective, and Issues

1:15pm – 2:45pm, Antigua 2

Presider: Anita Roychoudhury, Purdue University, aroychou@purdue.edu

Discussant: William Cobern, Western Michigan University

Presenters:

Daniel P. Shepardson, Purdue University

Devdutta Niyogi, Purdue University

Andrew Hirsch, Purdue University

Bruce R. Patton, The Ohio State University

Soyoung Choi, Purdue University

Yukiko Maeda, Purdue University

ABSTRACT: Given the relevance of climate change in our time, climate education needs attention from science educators. The findings from a study focused on this topic will be presented in this symposium. Student responses on the post-tests demonstrate that they learned some of the essential elements of climate and were able to distinguish weather from climate at a basic level. They also developed some understanding of related concepts such as the greenhouse effect. A deeper understanding of climate change and the underlying processes need improvement. The findings and the issues are likely to encourage future researchers to examine these topics.

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

S5.8 Retention & Graduate Student Development

1:15pm – 2:45pm, Curacao 5

Presider: Andrea R. Milner, Adrian College

S5.8.1 An Exploratory Study of the Relationship Between STEM Graduate Students Teaching Orientations and Teaching Practices

Joanna A. Gilmore, University of South Carolina, jagilmor@mailbox.sc.edu

Michele Kelly

ABSTRACT: Students commonly cite ineffective instruction as a primary reason for leaving a STEM field (Seymour & Hewitt, 1997). Research and discussions about how to improve retention in science, technology, engineering, and mathematics (STEM) disciplines stress the importance of improving STEM teaching, often through the incorporation of student-centered teaching approaches such as inquiry teaching in K-12 and undergraduate education (National Research Council, 2000). Graduate students' beliefs and practices related to student-centered teaching approaches is an area about which little is known (but see French & Russell, 2002; Saroyan et al., 2009; Volkmann & Zgagacz, 2004). This study examined STEM graduate students' orientations towards teaching or beliefs about teaching and learning a specific subject. It has been asserted that modifying teachers' beliefs about teaching and learning is prerequisite to changing teachers' practices (Nespor, 1987; Pajares, 1992). Research examining this hypothesis, however, reveals contradictory findings (Mellado 1988; Trigwell and Prosser, 1996). This study examined the belief-practice relationship using several measures of teaching practices and found few connections between graduate students' teaching orientations and practices. Barriers that participants cited to implementing student-centered teaching approaches such as inquiry teaching will also be discussed.

S5.8.2 Professional Development in College Science Teaching

Aimée K. Thomas, The University of Southern Mississippi, aimee.thomas@usm.edu

ABSTRACT: Graduate students earning a doctorate in the sciences historically focus their work on research and not development in teaching. However, for those who go on to a career in academia, a majority of time will be dedicated to teaching. During the past few years, graduate teaching assistants (GTAs) have been prepared to teach by attending a workshop with logistical information, but no pedagogy. This study was conducted to determine if there was a need for a teaching certificate program. The GTA respondents studied set goals that were consistent with faculty members across the country. The GTAs did not differ in their perceived level of competence based on experience level; however, the less experienced GTAs did perceive they needed more support than the experienced GTAs. To help GTAs develop a skill set that many graduates currently lack, it is recommended that a teaching certificate program be established to potentially impact the community through 1) training of GTAs, which contributes to the academic preparation of the future professoriate; 2) ensuring competent academicians, not only in content but also in pedagogy; 3) GTAs who encourage or incite undergraduates' interest to choose a career in the sciences; and 4) making graduates more marketable.

S5.8.3 Perceptions of Teaching Training and Department Climate Among US and International STEM Graduate Teaching Assistants

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

Engaging Diverse STEM Students in Transformative Learning

Larry D. Burton, Andrews University, burton@andrews.edu

David N. Mbungu, Andrews University

John F. Stout, Andrews University

ABSTRACT: International graduate teaching assistants (ITAs) are usually perceived as being "worse" instructors than their US counterparts (USTAs), and are often evaluated lower in student evaluations of teaching. This has resulted in extra training in language and US institutional culture given to ITAs. Using a theoretical model of factors that contribute to the teaching effectiveness of graduate teaching assistants (GTAs), differences in the perception of 82 ITAs and 92 USTAs about those factors are examined. The factors include; GTA training, factors in the department that facilitate

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teaching, the supervisor relationship, and peer teaching relationships. Additionally, GTA teaching self-efficacy and language and cultural proficiency were determined. For the GTAs teaching during the term they took the survey, their students responded to an evaluation of the GTAs' teaching. It was determined that ITAs and USTAs perceive the teaching climate of their department and their GTA training differently. ITAs have higher teaching self-efficacy and lower language and cultural proficiency, but report more course level responsibility. While the ITAs and USTAs did not significantly differ in student evaluations of their teaching; language and cultural proficiency was correlated to student evaluations. Implications for training and supervising ITAs are discussed.

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

S5.9 Related Paper Set - Assessment and Analysis of Undergraduates' Principled Reasoning About Biological Processes

1:15pm – 2:45pm, Bonaire 7

ABSTRACT: Our goals for undergraduates' understanding of biological processes are framed within the idea of principled reasoning. We define principled reasoning as reasoning guided by basic scientific principles and structured by habits of mind, or practices, which facilitate students' learning and understanding. The principles apply to multiple contexts and content areas and therefore promote learning across content areas. We focus on four practices: tracing matter, tracing energy, tracing information, and recognizing appropriate scales. This paper set includes five papers investigating questions and formats for assessing undergraduates' principled reasoning and reporting on ways in which weaknesses in principled reasoning affect their understanding of biological processes. Implications for instruction are discussed. The first paper investigates multiple formats for assessing students' ability to trace matter and energy through photosynthesis. The second paper looks at undergraduates' ability to trace information through meiosis and Mendelian genetics as revealed in tasks that ask them to make connections between standard representations. This is followed by a paper that examines students' ability to connect events taking place at different spatial and temporal scales. The final two papers explore the use of computerized lexical analysis for efficiently drawing assessment information from extended response items in large enrollment courses.

S5.9.1 Exploring Undergraduates' Understanding of Photosynthesis Using Diagnostic Question Clusters

Joyce Parker, Michigan State University

Merle Heidemann, Michigan State University

Mark Urban-Lurain, Michigan State University

Brett Merrit, Michigan State University

John Merrill, Michigan State University

Amy Lark, Michigan State University

Charles W. Anderson, Michigan State University

Gail Richmond, Michigan State University

S5.9.2 Undergraduates' Struggles to Trace Information in Genetics

Merle Heidemann, Michigan State University

Amy Lark, Michigan State University

Joyce Parker, Michigan State University

S5.9.3 Students' Use of Spatial and Temporal Scale in their Explanations of Biological Phenomena

Jonathon Schramm, Michigan State University

Charles W. Anderson, Michigan State University

S5.9.4 Moving Across Scales: Using Lexical Analysis to Reveal Student Reasoning About Photosynthesis

Casey Lyons, Michigan State University

Shauna Jones, Michigan State University

Rosa Moscarella, Michigan State University

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John Merrill, Michigan State University
Mark Urban-Lurain, Michigan State University

S5.9.5 Principled Reasoning and Conceptual Change: The Interplay Between Theory, Research and Practice
Mark Urban-Lurain, Michigan State University

Strand 6: Science Learning in Informal Contexts

S5.10 Science Outside the Classroom Walls

1:15pm – 2:45pm, Curacao 6

President: Terence P. McClafferty, Curtin University

S5.10.1 The Zoo Acuity Model: Depicting Students' Knowledge of Zoos

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

ABSTRACT: This study depicts 221 high school students', ages 15-18, mental representations of zoos. The students completed a demographic questionnaire, an interview, a concept map, and a ranking-concepts exercise. The findings indicated that: 1) students who had visited a zoo have a richer mental model of zoos than students who have never visited a zoo, 2) students who had visited a zoo with their teacher provided a deeper, richer understanding of the roles of zoos in conservation and education, 3) students who had never visited a zoo do have mental models of zoos, 4) students do not mention conservation with respect to zoos unless prompted, and 5) students did not mention the zoo's connection to species survival nor did they view zoos as a source of information for conservation-related topics. The data indicated that the students' knowledge consisted of seven themes: 1) organisms, 2) people, 3) amenities, 4) descriptive terms, 5) habitats, 6) education, and 7) conservation. The seven themes were defined and used to create the Zoo Acuity Model. The central constructs of the Zoo Acuity Model are the Observation Framework, the Interaction Framework, and the Information Framework.

S5.10.2 Why so Hard? Gaining Insights from School Teachers and Informal Science Education Staff Regarding Teacher use of ISE Resources

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

ABSTRACT: Although informal science education institutions (ISEIs) are poised to assist with the growing efforts to support STEM learning, there remains a disconnect between formal and informal learning institutions that limits such collaboration. As part of a larger study to better understand teachers who more frequently utilize ISEI resources (field trips, outreach programs, professional development), teachers and staff members from three different informal science institutions were queried to better understand perceived challenges and successes related to these interactions. Surveys, focus groups, and interviews were used to capture these perspectives. Findings from qualitative analysis suggest ways that the two distinct communities of practice (school and informal institution) limit more effective interactions. Furthermore, data from avid users suggest that they may be more effective of traversing beyond the community of practice defined by their school or classroom, compared to 'average' teachers who must first cross the boundary of their own community of practice, and then interact peripherally with the community of practice defined by the informal science institution.

S5.10.3 Closing the Gap: Teachers' Perceptions of Informal Science

Joy Kubarek-Sandor, Illinois Institute of Technology, John G. Shedd Aquarium, jkuba@sheddaquarium.org

ABSTRACT: This session will present the findings of a qualitative study describing teachers' perceptions of informal science education. The literature on teachers and informal science education is mostly limited to field trips. However, informal science education and the benefits they provide for learning experiences extend far beyond the field trip. Opportunities may include teacher professional development, curriculum resources, student programming and more. In addition, research has shown incongruencies between teachers' motivations versus their definition of a successful field trip. While teachers say they want to connect to the curriculum, they have reported a successful field trip being one that

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is fun and enjoyable. These gaps lend themselves to further study to gain a deeper understanding of how teachers perceive informal science education.

S5.10.4 Connecting Fieldtrip Learning to a School-based Ecology Unit: Using Socio-cultural Theory to Design and Study Learning Across Settings

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

Jennifer L. Weible, Pennsylvania State University

ABSTRACT: Sociocultural learning theory is used to study the development of the scientific practices of collecting data and using evidence and the development of the understanding of the concept “watershed” across three settings (school classroom, online wiki, and community stream monitoring in a fieldtrip). We analyze video data (~300 hours) from learners (n=79 consented ninth and tenth graders) as they participated in an ecology unit in school, authored an online wiki, and attended a community stream monitoring field event, led by environmental educators and scientists. We worked with the teachers of these youth to better integrate a stream monitoring fieldtrip into the curriculum through employing digital photography and wikis. Our goal was to study how technologies can (a) extend learners’ engagement with disciplinary knowledge and practices for more in-depth inquiry leading to robust explanation-building and (b) enrich one setting with knowledge and practices gained in another for further knowledge integration between informal and formal experiences.

Strand 7: Pre-service Science Teacher Education

S5.11 Preservice Teacher Beliefs & Attitudes

1:15pm – 2:45pm, Curacao 7

President: Carolyn S. Wallace, Auburn University

S5.11.1 The Intuitive Curriculum: Why Biology Teachers Tend to Shy Away from Philosophical and Social Issues

Arne Dittmer, University of Hamburg, arne.dittmer@erzwiss.uni-hamburg.de

ABSTRACT: There is a growing awareness that reflection on the nature of science and ethical aspects should be an integral part of science education. The study presented here investigates the relevance of socialisation in higher education for acquiring philosophical competence among biology teachers. In semi-structured interviews biology teachers were asked about the significance of philosophical problems and encounters in their own educational biographies and in their current classes. The results indicate that philosophical competence among biology teachers is acquired largely coincidentally and not as part of the biology curriculum. This poses a problem which can be interpreted on the basis of dual-process theories of social information processing, leading to a more profound understanding of the meaning of internalized convictions for the development of intuitive judgments and intentional behaviour. When the academic division of labour prevalent in institutions nowadays is internalized by teachers, they tend to marginalize philosophical thinking in science education and to delegate responsibility for such problems to other subject areas. In view of the fact that an academic career has an influence on which activities and contents are emphasized in the classroom, an argument will be presented for the integration of philosophical reflections in the education of biology teacher.

S5.11.2 Longitudinal Research on the Impact of Pre-Service Programs on Secondary Science Teachers' Beliefs and Practices

John W. Tillotson, Syracuse University, jwtilot@syr.edu

Monica J. Young, Syracuse University

Robert E. Yager, University of Iowa

John E. Penick, North Carolina State University

ABSTRACT: The NRC (2010) report on preparing teachers concluded that more comprehensive and longitudinal research is needed that examines the impact of specific pre-service learning experiences such as field experiences and pedagogical courses on science teacher outcomes following graduation. The purpose of this study was to longitudinally

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examine the perceptions of preservice science teacher education program graduates (N=151 total) concerning the impact of specific preservice program learning experiences on the development of their 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 studied using a battery of qualitative and quantitative instruments 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. The goal was to compare outcomes within and between teaching experience levels and preservice programs to examine the relative impact of critical learning experiences on science teacher development over time. The results suggest that duration of pre-service program, multiple sequential methods courses and diverse field experiences spanning multiple grade levels all contributed to significant differences in teacher quality across the three programs.

S5.11.3 Epistemological Views of Pre-Service Science Teachers: Role of A Pre-Service Science Teacher Education Course

Saiqa Azam, University of the Punjab, Lahore, Pakistan, sazam@ucalgary.ca

ABSTRACT: The paper describes a research aiming at challenging and hence tries to changing epistemological views of pre-service science teachers (PSTs) about science learning and teaching in a single teacher education course. The researcher as an instructor facilitated PSTs to change their existing traditional views about learning science and helped them to develop a more acceptable view. During the course students teachers explored various paradigms of learning and relevant learning theories in context of science learning and teaching. Student teachers were encouraged to reflect and discuss their own learning experiences of science and possible options for future science teaching. To evaluate the success of the course in terms of the intended objective of changing PSTs views about learning and teaching science, data was collected at the beginning and at the end of the course. Analysis of data demonstrated a significant shift in PSTs' views about science learning; though their understanding about the intended view of learning science (constructivism) was trivial at the end of the course. The research study provides some evidence for the effectiveness of the course and suggests a plan of action for future to improve the course aiming at changing views of student teachers' about learning science.

S5.11.4 Elementary Pre-service teachers' Attitude Towards Biotechnology Processes

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

Vivien M. Chabalengula, Southern Illinois University Carbondale, IL

Jonathan Chitiyo, Southern Illinois University Carbondale, IL

ABSTRACT: This study examined pre-service teacher's attitude towards biotechnology and its related processes. A sample comprised 88 elementary education pre-service teachers at a university in the Midwest of the USA. Sixty and 28 of these students were enrolled in Introductory Science Methods course and Advance Science Methods Course, respectively. Data were collected using a questionnaire which had 15 statements on a Likert-scale and required students to indicate whether each statement is acceptable or unacceptable. The results indicated that students from both courses generally held a wide range of attitudes towards biotechnology. Notably, majority of students had negative attitudes towards processes that involved the insertion or removal of genes in humans and animals. Implications for science teacher education, curriculum as well as recommendations for further research are discussed.

Strand 8: In-service Science Teacher Education

S5.12 Teacher Practice

1:15pm – 2:45pm, Curacao 8

Presider: Tamara E. Pepper, Lehigh University

S5.12.1 Citizen Science Research and Teachers: Understanding the Process and Implementation into the Classroom

Koomen Michele J. Hollingsworth, Gustavus Adolphus College, mkoomen@gac.edu

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ABSTRACT: This paper reports on a group of teachers followed into their science classroom after they completed a professional development program utilizing citizen science research. Two important frameworks guided this study: effective professional development and a practice of teaching science using inquiry. This study featured a mixed methodology including: pre and post assessments, observations of classroom teaching episodes, interviews with students and teachers and student work samples. Findings include: transformation of teaching practice, student outcomes and an emerging identity of both teachers and students as “scientist.” Implications for science teacher education and professional development are identified.

S5.12.2 Science Teachers' Orientations, Practices, Professional Development, and Intentions Regarding Project-Based Science focused on Sustainable Energy

Lisa A. Brooks, The University of Toledo, lisa.brooks2@utoledo.edu

Charlene M. Czerniak, The University of Toledo

ABSTRACT: The goal of the LEADERS Project is to improve science education by connecting students to local renewable energies industries and their environmental impacts through Project Based Science (PBS). The purpose of this study was to connect preliminary data on the practices, beliefs and intentions of eight participants in the first Summer Institute using the Theory of Planned Behavior (Ajzen, 1985) as a framework. Baseline survey, interview and observation data showed a range of participant classroom practices and beliefs about science teaching. Analysis of two PBS surveys revealed participants generally had high affinities, positive attitudes, and intended to implement PBS curricula in their classrooms. Teachers also reported high levels of control over their classroom and a moderate to high range of school community support of PBS. The understanding participants demonstrated in their written definitions of PBS did not, however, align well with expert views. This preliminary analysis will be followed up with observations of PBS implementation, interviews about teaching orientation and understanding of PBS, and an analysis of participant designed PBS lesson plans in the fall. Results from this study will enable the LEADERS project team as well as other PD developers to better select and mentor future teacher leader candidates.

S5.12.3 Teacher Knowledge of Practice Generated through Professional Experimentation with Model-based Reasoning

Rich Hedman, Sacramento State University Interim Director, Mathematics and Science Education Center, hedmanrd@csus.edu

Cynthia Passmore, University of California, Davis Associate Professor

ABSTRACT: Model-based reasoning is the process of reasoning with a set of ideas, specifically a scientific model. Emerging evidence suggests that model-based reasoning learning environments promote conceptual understanding in science, yet teachers are unfamiliar with these learning environments. Professional development is needed to assist teachers in establishing these learning environments. This research focused on indentifying and understanding the knowledge of practice generated by three teachers through professional experimentation with model-based reasoning. For this qualitative study we triangulated and organized a set of findings for each domain of the Interconnected Model of Professional Growth (Clarke & Hollingsworth, 2002). We found important changes in teachers ideas in each domain, for example, we found that teachers reported engaging students in tasks centered in model development facilitated the use of collaborative groups and guiding questions; teachers reported that their cognitive load increased during instruction as they attended carefully to student ideas; they reported increased student intellectual engagement and more rigorous student thinking. Our findings suggest the critical importance of tasks centered in model development and the guiding question feedback cycle, described significant network chokepoints which could impinge upon successfully engaging students in model development, and suggested the professional development implications of these findings.

Strand 9: Reflective Practice

S5.13 Reflection on Science Content Teaching

1:15pm – 2:45pm, Bonaire 6

President: Liesl M. Hohenshell, University of Wisconsin-Whitewater

S5.13.1 We Should Hardly Be Surprised That The Theory of Evolution Remains So Controversial...

Leslie Sandra Jones, Valdosta State University, lesliesj@valdosta.edu

ABSTRACT: The stubborn persistence of the "Evolution/Creationism Controversy" is rooted in a basic failure to understand and address the reasons religious students are so apprehensive about this important scientific theory. Over the years, I have become increasingly more convinced that the Evolution/Creationism controversy is inadvertently perpetuated by the science education process. Most of the staunchly creationist students in my classes provide evidence that evolution was not presented coherently at any time in their precollegiate education and they have little or no understanding of the epistemological distinctions between science and religion. Their biology lessons had been confusing and failed to teach about the role that this theory plays in organizing the extensive body of knowledge that has been assembled regarding the history of living organisms. Religious students have little reason to look for ways to reconcile evolution with the biblical explanations they had always believed. The conceptual change approach, which was developed as a teaching strategy, is also a useful analytical framework for demonstrating why educational efforts do not convince some students of the validity of biological evolution and why we continue to fail to facilitate the construction of solid conceptual understandings of evolution in science classes.

S5.13.2 An Instructor's Reflective Journey of Implementing a Thematic Approach to Teaching Nature of Science in a Pre-Service Education Biology Course

Sarah J. Krajewski, Western Michigan University, sarahkrajewski@yahoo.com

Renee Schwartz, Western Michigan University

ABSTRACT: This is an action research, self-reflective study in which the teacher-as-researcher assumes a meta-cognitive perspective to reflectively examine how nature of science (NOS) can be explicitly taught and assessed through daily lesson planning, teaching, and assessment. Research supports an explicit/reflective approach to teaching about NOS, but little is reported on teachers' journeys as they attempt to integrate NOS into everyday lessons. This report describes the journey of daily implementation of NOS throughout four units of a community college biology course (genetics, molecular biology, evolution and ecology). We report the challenges and successes faced by an experienced teacher implementing NOS for the first time. Student outcomes were also tracked by formative and summative assessments and interviews. Data include weekly lesson plans, pre/post reflective journaling, pre/post VNOS/VOSI questionnaires, writing pieces, and interviews. Results indicate the experienced teacher felt like a novice teacher when planning and teaching NOS in terms of time commitment and efficacy. Through persistence and reflection, she demonstrated growth in the ability to implement NOS aspects into daily instruction. As a practical example of putting research-based instructional recommendations into practice this study may be very useful for other teachers of biology who are learning to teach NOS.

S5.13.3 Analog Modeling of Earth Processes: A Case Study in Multidisciplinary, Guided Inquiry Science and Mathematics Education

Laura Serpa, University of Texas at El Paso, lfserpa@utep.edu

Olga Kosheleva, University of Texas at El Paso,

Milijana Suskavcevic, Rice University

ABSTRACT: The objective of this work is to use guided instruction to give teachers the tools needed to increase their content knowledge in science and mathematics. Faculty from mathematics education, physics, and geology collaborate to develop a series of activities that are designed to draw on the students' personal experiences through 1) an introduction into a specific local problem, 2) building models of the system under discussion, 3) making measurements and an accurate representation of the data, and 4) analyzing the significance of the results. The responses to these activities indicate the participants would be willing to repeat the experiments following established scientific methodologies even though it is considered difficult. The students indicate they would incorporate the experiments in their courses.

S5.13.4 An Integrative Model for Exploring the Development of Science Teachers' Personal Practical Knowledge

Chorng-Jee Guo, National Changhua University of Education, pfcjguo@cc.ncue.edu.tw

Ping-Tun Huang, National Changhua University of Education

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Li-Jeng Wu, National Changhua University of Education

ABSTRACT: Following Doyle (1990), a distinction between theoretical knowledge and personal practical knowledge is made. Since the study of teacher's personal practical knowledge is situated in a multi-dimensional space, involving interactions of experiences across time (past, present and future), among people, and at different locations, we need to attend to the personal, social, historical, and cultural dimensions holistically. An Integrated Model is proposed emphasizing the interactions and connections of teacher's self, the school/classroom contexts, and the professional community. Teachers' day to day practices are considered to take place in these arenas as they move continuously from one to another. An outline of the organizing elements relating to teachers professional activities in each arena is described. For the category identified as teacher's self, we use a heuristic model of PCK (Park & Oliver, 2008) consisting of six components, namely, teacher efficacy, knowledge of students' understanding in science, knowledge of science curriculum, orientation to teaching science, knowledge of assessment of science learning, and knowledge of instructional strategies for teaching science. For the school/classroom contexts: Context, Input, Classroom process, and Output. And finally, for the professional community: Theory, Research, Practice, and Policy. Potential use of the Model and its possible contributions are briefly discussed.

Strand 10: Curriculum, Evaluation, and Assessment

S5.14 Large-Scale Assessment and Curriculum Reform

1:15pm – 2:45pm, Bonaire 1

Presider: Mercy Ogunsola-Bande, Adamawa State University

S5.14.1 The Impact of an Innovative Science Curriculum on Students' Attitudes towards School Science

Indira C. Banner, University of Leeds, i.banner@education.leeds.ac.uk

Jim Ryder, University of Leeds

Jim Donnelly, University of Leeds

ABSTRACT: Research into students' attitudes towards school science has been of interest internationally for several years, more so due to falling numbers of students taking post-compulsory science. This paper examines students' attitudes in the context of a nationwide science curriculum reform which aimed to increase the relevance of school science to students and make it useful for everyday life. A strong emphasis has been placed on teaching about the nature of science and socio-scientific issues. By analysing in-depth student group discussions from four differing schools, students' attitudes towards the curriculum are discussed. The focus in this study is on students' perceptions of relevance and interest in the curriculum and is analysed using frameworks from the literature. Patterns across different student groups are identified and show that with some students a relevant curriculum with socio-scientific issues does not engender a positive response. The importance of curriculum development, in the context of other influences on attitudes towards school science, is questioned.

S5.14.2 Developing Instructionally Sensitive Assessment: Lessons Learned about the Manipulation of Close and Proximal Item Characteristics

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

Min Li, College of Education, University of Washington

Deanna Sands, University of Colorado Denver

Kellie Willis, College of Education, University of Washington

Michael Giamellaro, University of Colorado Denver

Margaret Anny Jones, University of Colorado Denver

Jennifer Feehan, University of Colorado Denver

ABSTRACT: Instructionally sensitive assessments are on the spot again. The main focus of the discussion has been the impact that instructionally insensitive assessments, large-scale assessment, have in making inferences about the quality of instruction students received or the effectiveness of educational programs. Yet, standardized test are being used for diverse accountability purposes (e.g., identifying poor-performing schools and districts, evaluating teacher

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effectiveness). The strategy used to study instructional sensitivity since the 80's has focused on the student performance on assessments already developed and how the performance could accurately reflect the quality of the instruction students received. This project focuses on filling a gap in this research area: how to develop instructionally sensitive assessments rather than just judging assessment already developed. This paper focuses on the lessons learned in developing and evaluating instructionally sensitive assessments for three science modules using judgmental and empirical evidence. The study addresses the following research questions: What module characteristics can be systematically manipulated to develop items at different distances (close, proximal, and distal) that prove to be instructionally sensitive? What are the manipulated characteristics from a module (as intended) that prove to be robust to variations in its enactment and its instructional sensitivity?

S5.14.3 Mathematical and Non-Mathematical Requirements in Upper Secondary School Physics Graduation Tests

Felix Schoppmeier, University of Duisburg-Essen, felix.schoppmeier@uni-due.de

Andreas Borowski, University of Duisburg-Essen

Hans E. Fischer, University of Duisburg-Essen

ABSTRACT: Mathematics competences are important factors in the learning and teaching of physics, including the assessment of physics. To understand just how integral mathematics competences are in physics assessments, this study examines 22 test sets of upper secondary school physics graduation tests, looking at aspects of mathematical and non-mathematical requirements, specifically. To analyze the tests, a manual with four mathematical and five non-mathematical requirements has been developed and evaluated. The tests include multi-step items that are divided into subtasks. The analysis shows that approximately 80% of the subtasks require mathematical knowledge to correctly solve them. Furthermore, in approximately 50% of the subtasks, exclusively mathematical knowledge is needed to solve items in the category "calculation". These results show that upper secondary school physics graduation tests examine too much mathematical competence and not enough non-mathematical competence.

Strand 11: Cultural, Social, and Gender Issues

S5.15 Inservice Teacher and Preservice Teachers' Attitudes towards Science and Children: Innovative Theoretical and Methodological Approaches

1:15pm – 2:45pm, Bonaire 2

Presider: Regina Suriel, University of Georgia

S5.15.1 Science Teachers' Views on Cultural Diversity: Contributions from Anthropology

Katemari Rosa, Columbia University, katemari@gmail.com

Felicia Moore-Mensah, Columbia University

ABSTRACT: Amongst the investigations dealing with teachers' perceptions of cultural diversity, this paper emerges from an anthropological framework to expand discourses on cultural diversity in science education. We examined how the discourses of cultural diversity in anthropology dialogue with the discourses on cultural diversity of the science education community. In addition, we interpreted how an anthropological analysis can help our understanding of science teachers' views on cultural diversity. Our choice for using an anthropological framework is because cultural diversity is one of the core themes of that field. Finally, we provided an analysis of how anthropology can address the question about the definition of diversity and how an examination from an anthropological perspective of training programs for diversity can contribute for building working definitions of diversity to the research and teaching of science.

S5.15.2 Nano-biotechnology Literacy for Sustainability in an International Context: Preparing the Public by Educating Teachers

Toth Eva Erdosne, West Virginia University, eva.toth@mail.wvu.edu

Graham Meadow Sherrill, West Virginia University

Brittany Witherspoon, West Virginia University

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Jennifer Trythall, West Virginia University

ABSTRACT: The research-based preparation of pre-service teachers is a pivotal element of educating the public for scientific literacy and related societal decision making. Scientific literacy is specifically important during the early phases of discovery where technological advances provide impetus for societal, economical and ecological applications. However, the risks and benefits at this early phase are not fully known. One current debate focuses on the risks and benefits of biotechnology and nanotechnology (jointly referred to as nano-biotechnology) discoveries. Thus, examining the perspectives of teachers, the professionals who educate the future public, is a critical need for science educators and researchers. Using a mixed method research design, we studied pre-service, elementary teachers' perspectives about nanotechnology application specifically as related to recovery from natural disasters. We found that students had a "cautiously optimistic" attitude towards nanotechnology and their reasoning for this attitude changed noticeably after the problem-solving activity that focused on nanotechnology application in a disadvantaged country as a way of recovery after a natural disaster. We anticipate that our work – that corresponds to the NARST 2011 theme – will be informative for members for their future research and instructional efforts, especially as related to the education of students in rural communities such as ours.

S5.15.3 Negotiating Emotions in Becoming a Social Justice Science Teacher

Maria S. Rivera Maulucci, Barnard College, Columbia University, mrivaram@barnard.edu

ABSTRACT: Becoming a social justice teacher, for high-poverty urban settings, is fraught with emotional ambivalence related to personal, professional, relational, political, and cultural social justice issues. Prospective teachers must navigate their sense of justice, grapple with issues of educational disparity, engage with theories of critical, multicultural, and constructivist approaches to teaching science, and articulate their vision and philosophy of teaching. Furthermore, their emotional navigation occurs at nested micro, meso, and macro levels. In this paper, I construct an emotional genealogy that provides an account of the historical development of an African-American, Caribbean preservice teacher's social justice stance. The emotional genealogy will focus on what emotions Nicole expresses, and how those emotions serve as markers for social justice issues she navigates, from micro to macro levels, in becoming a social justice Chemistry teacher.

S5.15.4 People and Places: The Use of Portraiture for Understanding Context in Science Classrooms

Cassie F. Quigley, Clemson University, cassieq@clemson.edu

Amy Trauth-Nare, Indiana University

Nicole Beeman-Cadwallader, Indiana University

ABSTRACT: Portraiture is as a method of inquiry that blends art and science (Lawrence-Lightfoot & Davis, 1997). The portraiture blends aesthetic and scientific aspects of inquiry through systematic use of observation, data collection, and interviews to describe phenomena while simultaneously capturing the beauty and aesthetic properties of phenomena. As such, portraiture is a methodological approach that encompasses all aspects of the study, including protocol, data collection and analysis, and presentation of findings (Yazzie, 2002). Through scientific writing, we endeavored to create authentic portraits of classrooms in which we studied. Although portraiture has been used commonly in other areas of educational research (e.g., Hakman, 2002; Harding, 2005; Lynn, 2006), only a few studies in science education (e.g., Larkin, Seyforth, & Laskey, 2009; Mulholland & Wallace, 2005) have employed portraiture. Our purpose is to describe the relevance of portraiture for framing, conducting, and analyzing research in science education, not simply a serving as a means for presenting the outcomes of a study. In this proposal, we provide portraits from two contexts as a way to outline how portraiture can be a viable methodology for science education researchers.

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Strand 12: Educational Technology

S5.16 Integrating Commercial Technologies into Teaching

1:15pm – 2:45pm, Bonaire 3

Presider: Vanessa D.I. Pfeiffer, University of Duisburg-Essen

S5.16.1 Integrating Geospatial Technologies in an Inquiry Energy Unit with Urban Middle School Students

Violet Kulo, Lehigh University, violet.kulo@lehigh.edu

Alec M. Bodzin, Lehigh University

ABSTRACT: This paper describes the integration of geospatial technologies in an interdisciplinary Energy unit developed for diverse middle school students. The Energy unit utilizes 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 that are discussed in the literature. The study was implemented in five eighth-grade classes in a culturally diverse urban middle school. Data were gathered through pre/posttest assessments, daily classroom observations, and daily reflective meetings with the teacher. Findings revealed that integrating geospatial technologies in an 8th grade science Energy unit helped students at all ability levels increase their science content knowledge and develop spatial analysis skills. Energy conceptual knowledge gains were statistically significant.

S5.16.2 Google Earth: How Are Teachers Using This Virtual Globe and How Can They Be Further Supported?

Rebecca R. Deutscher, University of California at Berkeley, rrdeutscher@berkeley.edu

ABSTRACT: Google Earth is a powerful virtual globe that helps students see the world from a variety of angles and perspectives. The goal of this study was to examine teachers' background with Google Earth nationally, to find out how they are currently using it, and learn how to better support them. There were 1140 teachers who participated. The results indicated that teachers are positive about it, are more likely to use it if integrated into a curriculum, felt it would not be difficult to use, have little professional development in it, and felt that access to computers is the biggest hurdle. By understanding how to support teachers, it is hoped that we can help students better understand the world around them.

S5.16.3 Electronic Interactions in Science Classrooms at no Cost: Google Voice as a Formative Assessment Tool

Brian C. Baldwin, Kean University, brian@bcbaldwin.com

ABSTRACT: An exploratory study investigated the implementation of GoogleVoice SMS messaging as a formative assessment tool in science teacher education classrooms. Within the context of a modification of the well-known candle-cylinder experiment, results indicated that the technology-enhanced formative assessment tool was able to collect student responses and predictions in real-time without prior programming of back-end software or electronic slides prior to instruction. Results indicate the need for future curriculum development for its use in teacher education and K-12 classrooms.

Strand 13: History, Philosophy, and Sociology of Science

S5.17 Symposium - Objectivity in Science and the Study of Pseudoscience in Education

1:15pm – 2:45pm, Bonaire 4

Presider: Ron Good, Louisiana State University

Presenters:

Michael R. Matthews, University of New South Wales

Norman G. Lederman, Illinois Institute of Technology

Judith S. Lederman, Illinois Institute of Technology

Catherine M. Koehler, Illinois Institute of Technology

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Larry D. Yore, University of Victoria

ABSTRACT: The topic of objectivity in science is closely related to and has implications for the study of pseudoscience in society. The public is constantly exposed to claims that use the veil of science to promote products that have little, if any, scientific evidence behind them. From subluxation chiropractic to parapsychology to astrology to intelligent design to weight loss pills, people are bombarded with claims of easy solutions to complex problems. Equally troublesome is the inclusion of traditional forms of knowledge in science curricula without consideration of the ontological assumptions and epistemological beliefs embedded in the knowledge. Should a person be considered scientifically literate if she is unable to identify and analyze common pseudosciences and alternate forms of knowledge about nature and naturally occurring events? How might science education help students and society in general become more proficient in recognizing common pseudosciences? These questions are closely related to the topic of objectivity in science and this panel discussion will consider the pros and cons of including the study of pseudoscience in the school science curriculum.

Strand 14: Environmental Education

S5.18 Science Teacher Education as a Context for Environmental Literacy Improvement

1:15pm – 2:45pm, Bonaire 5

President: Maria Ferreira, Wayne State University

S5.18.1 Satisfaction of Pre-service Science Teachers' Basic Psychological Needs While Solving an Environmental Problem

Guliz Karaarslan, Agri Ibrahim Cecen University, Middle East Technical University, kguliz@metu.edu.tr

Hamide Ertepinar, Middle East Technical University

Semra Sungur, Middle East Technical University

ABSTRACT: The purpose of this study was to examine how pre-service science teachers' (PST) basic psychological needs that are competence, autonomy and relatedness were satisfied while solving the environmental problem namely "Why worry about extinction" during an environmental course. The qualitative data were obtained from five PSTs who were taking this environmental course. Multiple case study was conducted by using multiple sources that are interviews, observations and assignments. To analyze data, constant comparative method and open coding were used. Two categories (cognitive features and instructional features) and five codes (sense of confidence in action, sense of self initiation, awareness of personal role in the nature, awareness about environmental organizations, collective construction of ideas and student guided discussion) were explored in the data. When PST felt confident in action and were aware of their personal role in the nature, their sense of competence was fulfilled. Moreover, feeling initiative supported their needs for autonomy. When they were aware about environmental organizations, their sense of relatedness was satisfied. Collective construction of ideas and student guided discussion supported their needs for autonomy and relatedness. In conclusion, PSTs' basic psychological needs were fostered while solving and discussing the problem.

S5.18.2 How Do Pre-Service Science Teachers Perceive Local and Non-Local Environmental Problems?

Busra Tuncay, Giresun University, tbusra@metu.edu.tr

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The study aimed to investigate how pre-service science teachers perceived local and non-local environmental problems and whether there were any differences in their perceptions. A convenience sample of 114 pre-service science teachers participated to the study. For data collection four local and four non-local environmental cases about deforestation, e-waste, oil spill, and global warming environmental problems were prepared by the researchers and ten questions about the certainty, tangibility, and seriousness of the causes and the consequences of the problems, participants' knowledge levels and concerns as well as their perceptions about the trend of the environmental problems after 20 were asked for each of the environmental cases. The participants were found to be aware of the certainty, tangibility, and seriousness of the causes and the consequences of both local and non-local

environmental problems and the fact that their lives would be affected by them. Moreover, descriptive findings of the study revealed that there were some differences their perceptions—including their risk perceptions—in favor of local environmental problems indicating that emphasizing local environmental problems both in mass media and environmental education programmes may lead people to behave more pro-environmental.

S5.18.3 Exploring Prospective Science Teachers' Epistemological Beliefs regarding Learning in the Domain of Environment

Elif Adibelli, Middle East Technical University, aelif@metu.edu.tr

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: This study aimed to investigate prospective science teachers (PSTs)' epistemological beliefs regarding control and speed of learning in the domain of environment through comparing with those in the domains of physics, chemistry, biology and mathematics. The participants of this study consisted of 12 female PSTs. To assess PSTs' epistemological beliefs regarding learning a semi-structured interview developed by Schommer-Aikins (2008) was used. 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. Miles and Huberman's (1994) approach was used to analyze qualitative data. The analyses of PSTs' responses to a set of interview questions indicated that the PSTs believed in acquired ability to learn more in environment since unlike other domains ability to learn in environment is related to having an interest rather than intelligence and can be improvable through experiences or observations. Moreover, the PSTs considered that environmental knowledge can be learned quickly through observation with naked eye unlike knowledge in other domains which are learned slowly due to being abstract. These findings suggest that learning problem in environment or having responsible environmental behavior may be related to personal epistemological beliefs.

S5.18.4 Environmental Knowledge, Attitudes, and Awareness of Pre-Service Teachers and Faculty

Bruce Johnson, University of Arizona, brucej@email.arizona.edu

Deborah Barca, University of Arizona

Dennis Rosemartin, University of Arizona

ABSTRACT: As part of a larger effort to incorporate environmental literacy into the teacher preparation programs at a large, public university in the southwestern U.S., the current study used a mixed method approach, including written questionnaires, open-ended questions, and interviews, to collect data on the environmental understandings, attitudes, and actions of 234 pre-service teachers and 31 teacher preparation faculty members. Faculty members were found to have a much greater understanding of ecological concepts and applications to their lives, such as being able to identify fossil fuels as the main source of electricity in their city while pre-service students incorrectly believed that solar was a main source. While pre-environmental attitudes were common across groups, pre-service teachers had a much higher belief in the ability of technology to solve environmental problems. Both groups felt that including environmental learning in the curriculum was important, and targeted interviews explored why they felt that is important as well as their views on how it might be done.

Strand 1: Science Learning, Understanding and Conceptual Change

S6A.1 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.1.1 Improving Student Understanding of 'Size and Scale' through a Variation Theory Approach

Su Swarat, Northwestern University, s-swarat@northwestern.edu

Denise Drane, Northwestern University

Greg Light, Northwestern University

ABSTRACT: "Size and scale" has been identified as one of the "big ideas" in nanoscience education at the K-12 and undergraduate levels. This paper builds on a series of studies on "size and scale" presented at the last three NARST conferences, and reports the results of a randomized controlled trial evaluating an intervention to enhance undergraduate students' conceptual understanding of this concept. The intervention was based on the Variation Theory

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(Marton & Booth, 1997) and was designed to raise students' awareness of the three key aspects of variation in conceptions of "size and scale". Using contrasting examples that highlight the differences between the four conception categories of "size and scale", we expected students to become aware of their own understanding in terms of what differentiates their existing conception from other categories, and what the areas of improvement are. Our mixed-method analysis revealed some preliminary evidence for the success of the intervention — the intervention group gained more on "scale category" items both in terms of correctness and sophistication scores than the control group who received traditional instruction on "size and scale".

S6A.1.2 Investigating 6th Grade Students' Causal Reasoning in Biodiversity

Hayat Hokayem, MSU, alhokaye@msu.edu

Gotwals Amelia Wenk, MSU

ABSTRACT: This study investigates 6th grade students' reasoning of ecology and biodiversity when they are presented with food web scenario and with bar graphs related to biodiversity. We analyzed 110 written assessment items that required students to write scientific explanations about the effect of changing a certain population on other populations of the food web. We developed an iterative coding scheme that emerged from the data and that employed causal reasoning due to the nature of the assessment items. The results revealed that students' causal reasoning was mainly split between two types: the first was causal reasoning that considered only the two populations, and the second was reasoning that diverged to think about other populations in the ecosystem. Moreover, we also found that the student found it more difficult to relate representation labels to scientific biological concepts. However, in most situations, when students answered in scientifically inappropriate manner, it was mainly due to lack of specific scientific content rather than faulty reasoning. Those results have implications towards identifying the key content knowledge and skills for different kinds of scientific explanations in addition to rethinking the current learning progression proposed in ecology and biodiversity.

S6A.1.3 Chinese and Australian Grade 6 Children's Conceptual Understanding of Science

Ying Tao, University of Western Australia, taoy03@student.uwa.edu.au

Mary Oliver, University of Western Australia

Grady Venville, University of Western Australia

ABSTRACT: The purpose of this study was to compare Chinese and Australian Grade 6 children's conceptual understanding of science. Participants were Grade 6 children from a public school, a private school, and a rural school in Hunan Province, China (n=140) and Western Australia (n=89). Children's understanding was assessed by a science quiz developed from the past TIMSS science released items. In-depth interviews were carried out to further explore children's conceptual understanding of living things, the Earth, and floating and sinking. Science teachers and school principals were interviewed, classroom observations completed and documents collected to ascertain different approaches to elementary science curricula in the two countries. The science quiz results revealed that the distribution of Chinese and Australian Grade 6 children's responses to each quiz item displayed similar patterns. Interviews indicated that Australian Grade 6 children, however, demonstrated relative strength in their conceptual understanding of life science and physical science. Children from both countries were weak in understanding complex concepts in the domain of earth science.

S6A.1.4 The Development of Learners' Attitudes Towards Different Natural Scientific Subjects - A Longitudinal Study

Alexandra Pleus, Humboldt-University Berlin, Germany, alexandra.pleus@biologie.hu-berlin.de

Zu Belzen Annette Upmeyer, Humboldt-University Berlin

ABSTRACT: The key aspects of the following research are the development of learners' attitudes and the transition from primary to secondary school as well as between different natural scientific subjects and their influence on attitudes. Within the framework of a longitudinal study based upon the attitude expressions of primary and secondary school learners (Christen, 2004) the data of students' attitudes are collected. Learners' attitudes are influenced by factors such as the class atmosphere, behavior toward classmates and teachers, and the didactic-methodological organization of biology class. Previous researches do not incorporate how biology as a scientific subject is being introduced to the

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learners, how it is perceived and how this perception influences the attitude development. A main result is the downward tendency of the enjoyment of learning and the increase of boredom and frustration. Especially before the transition, the number of goal and achievement oriented learners increases. In addition, the study focuses on the questions, which subject-specific aspects influence the attitude development and which concepts do learners develop concerning gaining insides? Via interviews, the causes for such developments regarding to the transition of schools as well as the structure of biology within the classes mentioned is being analyzed.

S6A.1.5 Triangulating America's Science Literacy

Adam V. Maltese, Indiana University, amaltese@indiana.edu

ABSTRACT: The amounts of information and user on the web is consistently growing worldwide. The purpose of this paper is to describe attempts to use Google search trends, Wikipedia site traffic and other statistics in an attempt to provide useful information on what Americans “need” to know. While there are numerous areas of science where the public is shown to be deficient, for the sake of brevity we will focus on three of the major issues commonly discussed: global warming, evolution and cancer. Our findings indicate similarities in the results from multiple data sources. We believe that the use of multiple sources provides a more robust picture of the science and health topics Americans need to know.

S6A.1.6 Interpretive Discussion of Text in Physics

Shulamit Kapon, University of California Berkeley, and Tel Aviv University, shulamit.kapon@berkeley.edu

ABSTRACT: This paper examines the potential of interpretive discussion of text in the instruction of physics. The text used is a popular scientific article entitled $E=MC^2$ written by Albert Einstein. The data were drawn from an interview with an 11th grade student who was studying physics in high school at the honors level. The interview was designed as an interpretative discussion of the text. The preliminary analysis suggests that (a) interpretative discussions of quality texts in physics can contribute to a better conceptual understanding of physics as well as the nature of science; (b) the mediation that the teacher (i.e. the discussion leader) provides through the discussion plays a crucial role in the students’ understanding of the text.

S6A.1.7 Sound Transmission: Fourteen old Students' Conceptions and Learning from a Teaching-Learning Sequence

Eva West, Eva.West@ped.gu.se

Anita Wallin

ABSTRACT: The purpose of this study is to report on students’ generalized learning of the transmission of sound. The transmission of sound might be interpreted and conceptualized in different ways by one and the same student depending on the media or lack of media. However, the students’ generalized conceptualisation of sound transmission is not an easy task. In this study a research based teaching-learning sequence was developed and used which included the use of a particle model, students’ preconceptions and formative assessment as tools for learning. 77 students’, aged 13-14, conceptions and learning of sound and sound transmission were analyzed from pre-, post- and delayed post-tests. The method of analysis involved identifying different conceptual categories according to an attempt to interpret the underlying theoretical framework in students’ answers. This paper found that students’ conceptions of sound changed from showing no theory or showing a material interpretation of the nature of sound to more often describing the phenomenon of sound transmission by use of a framework of process or a mix of material and process interpretations. This result was also visible one year after the teaching intervention. In short, explicit discussions of different ways to represent sound, including the use of the term sound wave, and use of formative assessment can be beneficial to students’ learning.

S6A.1.8 Modelling-based Knowledge Building - The Case of a Blind Student

Rosaria Justi, Universidade Federal de Minas Gerais Education, rjusti@ufmg.br

Nilmara B. Mozzer, Universidade Federal de Minas Gerais Education

ABSTRACT: Students’ generation of internal representations - a process named visualization - is highly significant in chemistry education. From the recognition of such an importance, it also emerges a relevant topic about which very

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little is known: blind students learning of science. In an attempt to contribute to this unexplored research area, in this paper, we report part of a study that aimed at investigating two research questions: What are the relationships between external and internal representations for blind students? How do blind students access, understand, and use the macroscopic, sub-microscopic and symbolical levels of representing scientific knowledge? Data were collected from video-recording of a blind student performing modelling activities on the dissolution process, and being interviewed simultaneously. From our results, we also suggest some guidelines for blind students' teachers.

S6A.1.9 Confirmation for Increased Attention to Four Core Areas of Evolution Understanding: Observations from Classroom Instruction

Margaret M. Lucero, University of Texas at Austin, mmlucero@mail.utexas.edu

Anthony J. Petrosino, University of Texas at Austin

Nate K. Mcvaugh, University of Texas at Austin

Jeffrey Birchfield, University of Texas at Austin

ABSTRACT: Even though evolution is the underlying framework upon which all biology is based, when it comes to learning evolutionary concepts, many students encounter obstacles. There are many reasons as to why these obstacles occur. Among them are: evolution being treated as a discrete topic among many within a biology curriculum, misunderstanding the nature of science, and personal difficulties with understanding due to evolution's seemingly abstract nature. We propose a different way of thinking of and teaching evolution in grades K-12, and it surrounds four core areas essential to the understanding of evolution: variation, selection, inheritance, and deep time. With these four areas providing a foundation with which to learn evolution, students may encounter less conceptual difficulty in learning and have sustainable knowledge of evolutionary concepts. A classroom experience with high school biology students participating in an evolutionary instructional unit was used to confirm the importance of having knowledge of these four areas. Without this knowledge, students had difficulty clearly articulating basic understanding of evolutionary concepts and clung to misconceptions. Recommendations and directions for further study are also discussed.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S6A.2 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.2.1 Interactions between Classroom Discourse, Teacher Questioning, and

Julie B. Smart, Presbyterian College, jbsmart@presby.edu

Jeff C. Marshall, Clemson University

ABSTRACT: The present study examines interactions between classroom discourse, specifically teacher questioning, and related student cognitive engagement in middle school science. Observations (N=75) were conducted throughout the school year in middle school science classrooms using the Electronic Quality of Inquiry Protocol (EQUIP) to measure observable aspects of student cognitive engagement and discourse factors during science instruction. Results from these observations indicate positive correlations between students' cognitive engagement and the following aspects of classroom discourse: questioning level, complexity of questions, questioning ecology, communication patterns, and classroom interactions. A sequential explanatory qualitative analysis provides a detailed look at each of these aspects of classroom discourse within the science classroom. Implications for classroom practice, teacher education, and professional development are discussed.

S6A.2.2 Effectiveness of Virtual Laboratories in Terms of Learning Environment, Attitudes, and Achievement among High School Genetics Students

Rachel R. Oser, Curtin University of Technology, Australia, rachel.oser@gmail.com

Barry J. Fraser, Curtin University of Technology, Australia

ABSTRACT: As our society becomes increasingly technological, research suggests that students, too, benefit from technology-rich learning environments. In an effort to both allow students laboratory experiences that would not

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otherwise be possible in high school settings, and to augment the integration of technology within science classrooms, virtual laboratories can be used to simulate real laboratories and encourage students to employ scientific thinking skills. This study investigated the effectiveness of such virtual laboratories in terms of students' perceptions of the learning environment, attitudes towards science, and achievement. Classes of students who utilized virtual laboratories were compared with classes of students who did not. Data were obtained by administering a questionnaire measuring students' perceptions of the learning environment, attitudes, and achievement; this was complemented by data from interviews with students. No significant differences were found between instructional groups indicating that the use of virtual laboratories does not negatively impact students. The results of this study inform practical teaching and learning methods in addition to adding to the body of knowledge in the field of learning environments.

S6A.2.3 The Complex Nature of Physics and Engineering Students' Academic and Social Networks in Higher Education

Jonas Forsman, Uppsala University, jonas.forsman@fysik.uu.se

Rachel F. Moll, Vancouver Island University

Staffan Andersson, Uppsala University

Cedric Linder, Uppsala University

ABSTRACT: The continuing declining intake of university students into science and engineering has increasingly become a critical educational concern. Student retention studies have identified integration into the universities' social and academic systems as key factors that can shape students' retention choices, and learning. In this study complexity and network theory analysis tools were used to examine the academic and social networks that students form in year one and year three engineering classes. Three physics and engineering classes at a Swedish university were surveyed, two year one classes and one year three class. Students were asked to record the names of the students in their class that they interacted with and to characterize the nature of their interactions as social, academic or both. Each type of network was mapped and trends across courses and across years were observed. Preliminary results indicate that similar dynamics were observed in social, academic and both social and academic networks within and across courses and that students form strong social and academic networks within their program and weak links across programs. Quantitative measures of networks and individuals within networks will be correlated with measures of student retention such as attitudes towards their program.

S6A.2.4 Investigating the Influences of 5th Graders' Learning Motivation on Dissolution Conceptual Change

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Hsiao-Lin Tuan, National Changhua University of Education, Changhua, Taiwan, R.O.C.

ABSTRACT: The study used quantitative research methods to explore 5 graders' learning motivation and conceptions of dissolution changed during their involvement of e-learning platform designed based on dissolution conceptual change. 32 5th graders (age 11-12) participated in study. All students were asked to finish the prior conceptual test and learning motivation questionnaire (Tuan, Chin, & Shieh, 2005) before they learned the dissolution concepts. After experiencing the e-learning instruction, students have to fill learning motivation and alternative dissolution conceptual test again in order to understand the change of learning motivation and dissolution concepts of these students. During e-learning, we also collect subjects' responses before and after the learning the conceptual change lesson, and their motivation and emotion data on the e-learning platform. The study found students' conception on dissolution and learning motivation had increased significantly ($p < .05$). After the conceptual conflict phase, the role of learning motivation especially self-efficacy and active learning strategies play important role in students' conceptual change

S6A.2.5 Exploring the Structural Relationships between Taiwan University Students' Conceptions of Learning Biology and Epistemological Beliefs toward Biology

Liang Jyh-Chong, National Taiwan University of Science and Technology, aljc@mail.ntust.edu.tw

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

Guo-Li Chiou, National Chiao Tung University

ABSTRACT: This study was conducted to explore Taiwan university students' conceptions of learning biology and their epistemological beliefs toward biology, and the relationships between these two. The participants in this study included

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657 Taiwan university students with a major in biology-related fields. They were asked to respond to two questionnaires, that is, Conceptions of Learning Biology survey (COLB) and Epistemological Belief in Biology scale (EBB). Structural equation modeling was applied to examine the relationships between the aspects of COLB and EBB. Through confirmatory factor analysis, this study revealed satisfactory validity and reliability of both questionnaires for assessing university students' conceptions of learning biology and epistemological beliefs toward biology. The correlation analysis, in general, showed that students with lower-level conceptions of learning biology tended to have less advanced epistemological beliefs in biology. On the other hand, students with higher-level conceptions of learning biology tended to possess more mature epistemological beliefs in biology. Moreover, the structural equation modeling analysis confirmed that university students' conceptions of learning biology guided their epistemological beliefs toward biology, but not the conclusion that epistemological beliefs guided students' conceptions of learning. This result contradicts the assumption proposed by many educators that epistemological beliefs will guide students' conceptions of learning.

S6A.2.6 An Aptitude-Treatment-Interaction Study: Effect of Interaction Between Inquiry-Teaching and Field-Dependency on Physics Achievement and Attitude

Hanife C. Sen, Yuzuncu Yil University, Middle East Technical University, hanifecan.sen@gmail.com

Ali Eryilmaz, Middle East Technical University

Sahin Mine Gokce, TED Ankara College, Middle East Technical University

ABSTRACT: This study investigates the effect of inquiry versus lecture instruction and their interactions with cognitive styles (field-dependent, field-mixed, and field-independent) on achievement and attitude toward electric circuits. Instructional materials were developed for inquiry. Teachers' classroom practices were accepted as lecture. Physics achievement test (PACT), physics attitude scale (PATs), observation checklists, and GEFT were data collection instruments. Treatment was implemented to 298 11th grade students. MANCOVA was used to analyze data. The dependent variables were achievement (PSTACH) and attitude (PSTATT) scores. Gender was covariate. Group membership was named as "MOI; methods of instruction" (2 level categorical) and used as fixed factor with other group membership variables, achievement pre-test scores (PREACH), attitude pre-test scores (PREATT), School, previous physics course grades (PPCG), cognitive style (CoS), and the interaction terms of MOI*PREACH, MOI*PPCG, PREATT*MOI*PPCG*CoS, MOI*PPCG*CoS, PREACH*School, and PREACH*PREATT. In general, inquiry was effective than lecture with respect to PSTACH. However, there was not a significant difference in effectiveness of both methods in improving students' attitudes. In essence, each method of instruction was not effective on improving attitudes. Although this study could not find any statistically significant interaction effect of MOI and other independent variables on students' scores, practical significance was investigated for interaction terms.

S6A.2.7 Influences of a STEM Mentoring Program on Underachieving Middle School Students

Robbie L. Higdon, Clemson University Clemson, SC, rhigdon@clemson.edu

ABSTRACT: Mentoring programs are one intervention employed by schools to address students who are underachieving and, possibly, at-risk for school failure. This study explores how participation in a mentoring program impacted student classroom behaviors and contributed to academic achievement. Within this case study, various forms of data were collected on four students who were participants in a STEM mentoring program. Thematic analysis of the evidence suggested building self-esteem and holding students accountable as key benefits from participating in a mentoring program. In addition, evidence pointed to students' lack of understanding about the meaning of grades and a demonstrated disconnect between effort and achievement as impediments to academic success. Overall, the participants realized success in various content areas and were motivated to maintain their academic achievements.

S6A.2.8 Investigating the Creation of a Community of Physics Learners

Renee Michelle Goertzen, Florida International University, rgoertze@fiu.edu

Eric Brewe, Florida International University

Laird H. Kramer, Florida International University

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ABSTRACT: Our research group has been implementing reforms in introductory physics instruction at our institution. One aim of this reform has been to create a community of physics learners among the students attending this institution, which is a large, urban, Hispanic Serving Institution. We report on a study of the factors that contribute to students' sense of community within this community of learners. In previous work, we have reported gains in conceptual learning and attitudes about learning science in those students enrolled in the introductory courses taught with Modeling Instruction, which operates in a collaborative learning environment. The establishment of a community of learners has been supported by the availability of Modeling Instruction and the Physics Learning Center (PLC), a set of rooms available for student-initiated groupwork. Using video recordings of the Modeling Instruction classes and selected students' work in the PLC, along with interviews with selected students, we explore how a community develops through the daily interactions of students and faculty, and how the larger community of learners creates a sense of community for a single individual in that community.

S6A.2.9 Investigating Minority Student Participation in an Authentic Science Research Experience

Stephanie D. Preston, sdp163@psu.edu

ABSTRACT: Despite the number of low-income, racial/ethnic minorities, and females of all ethnic and racial backgrounds who are initially interested in science very few of them thrive in the discipline. Some scholars suggest that the declining interest for students underrepresented in science is traceable to K-12th grade learning experiences and access to participating in authentic science. Consequently, the diminishing interest and lack of access of minorities and women in science contributes negatively to the representation of these groups in the STEM disciplines. The purpose of this study was to investigate the potential benefits participation in a science research experience has for underrepresented student groups using a science research component of a TRIO program. The design of this study examines the nature of students' engagement in the research experience by investigating the impact of the it has on their identity as science learners, participation in the scientific community, and their understandings of the nature of scientific practices within the context of their experiences. Findings revealed that students who participated in the research experience shared increased enthusiasm in learning science, and were able to successfully engage in some cultural practices of science, such as using inscriptions, constructing explanations, and collecting data.

S6A.2.10 Teacher Interactions with Technology: The Comparison of Two Teachers' Discursive Practices Web-based Science Environment

Alicia M. Trotman, Michigan State University, trotmana@msu.edu

Michelle Williams, Michigan State University

Matthew Koehler, Michigan State University

ABSTRACT: This study reports on the discursive practices (verbal and non-verbal actions) of two 5th grade elementary teachers during the implementation of a Web-based Inquiry Science Environment (WISE) curriculum unit. The curriculum unit was based on inherited and acquired traits of organisms, including plants and animals. Using Interaction Analysis, this study was conducted to understand how teacher orientations function as filters to interpret their discursive practices, shaped by activity structures embedded within a science technology learning environment. It addresses the following questions: (1) What are the non-verbal and verbal teacher-student interactions within a Web Inquiry Science Environment? (2) Given teachers' orientations and similar student outcomes, how do the teachers' functions of communication (e.g. non-verbal actions, questions) compare to each other? The findings show that less experienced science teachers can create learning communities that promote successful outcomes for their students.

S6A.2.11 Children in Science Fairs: Interviews with Parents on the Family Experience

G. Michael Bowen, Mount Saint Vincent University, gmbowen@yahoo.com

John L. Bencze, OISE/University of Toronto

Dianne Fraser, Mount Saint Vincent University

ABSTRACT: Considering the number of students who participate in them each year, science fairs are an under-researched area of science education. As part of a broader research agenda examining and conceptualizing science fairs, in this study we conducted survey questionnaires and then interviews with parents who had had children participate in

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science fairs. In these, we had parents discuss their role in working with their children, what understandings of science were held and were developed through these activities, and how the parent perceived the overall science fair experience that their child (or children) had. Insights from these interviews that may be useful for schools and science fair organizers/judges are discussed at the end.

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

S6A.3 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.3.1 Research and Documentation of 4 year-old Understanding of Science

Judith A. Burton, Public School Teacher, jahburton@yahoo.com

ABSTRACT: Twenty-five teachers, from a variety of public and private school settings, are conducting research over a three year period to explore and document what 4 year-olds know and are able to do in Science before they reach Kindergarten. The presenter is a prekindergarten teacher in an urban elementary school and is one of the teacher researchers collaborating with the grant. This Interactive poster session will explain the methodologies and resources used in this study, the training the teachers received, as well as, how the children were assessed and how their understanding of Physical Science and Life Science was documented using a Flip Camera, Digital Camera, drawings and documentation panels. Some of the interesting results of our inquiries with young children will also be revealed.

S6A.3.2 Student Ideas about the Science of Sound Before and After Engineering-Design-Based Instruction

Kristen B. Wendell, Tufts University, kristen.bethke@tufts.edu

Hee-Sun Lee, Tufts University

ABSTRACT: The purpose of this study was to investigate elementary students' learning of sound in classrooms enacting a four-week engineering-design-based curriculum unit. The curriculum situated learning about the science of sound within the activity of musical instrument engineering. After a series of guided investigations that involved building and analyzing miniature musical instruments, each student dyad designed, constructed, and demonstrated a musical instrument of their own invention. This study took place in three urban third- and fourth-grade classrooms, with 31 participants total. Before and after curriculum enactment, each participant completed three separate interview scenarios: analyzing a xylophone, creating sounds with strings and hooks, and playing rubber-band instruments. All three scenarios were intended to elicit ideas about sound production, sound transmission, and pitch. After instruction with the engineering-design-based unit, the students' ideas about sound became more sophisticated and mechanistic. They shifted from describing causes and effects only in terms of what they could easily see and hear to proposing more complex mechanisms that they could not directly observe. This suggests that even in elementary school, when engineering design is used as the context for scientific investigation, students engage in deep reasoning about physical causes and effects.

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

S6A.4 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.4.1 Teachers' Understandings About Organs and Organ Systems in Frogs and Pigs

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

ABSTRACT: The purpose of this study was to determine if United States of America (USA) science teachers' subject matter knowledge of the frog and pig's internal anatomy: 1) was analogous with their number of years teaching, 2) inspired their reason for attending a workshop, 3) correlated with the subjects they taught, and 4) paralleled with their use of dissection. The study population consisted of 71 science teachers, 47 females and 24 males. During a dissection workshop, the teachers were given a blank piece of standard paper and were asked to draw what they thought was inside a frog or pig (15 minutes). Each drawing was scored using a rubric. The preliminary results show that there is a

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correlation between subject matter knowledge of frog/pig internal anatomy, the number of years a teacher has taught, and whether or not they employ dissection. Additionally, the teachers demonstrated a similar pattern to that shown by students in previous studies. The teachers were able to draw individual organs, but they were not able to draw the organs in completed organ systems.

S6A.4.2 Argument-Based Inquiry Approach to Teaching 7th Grade Science in Korea

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

Jeonghee Nam, Pusan National University

Eulsun Seung, Indiana State University

ABSTRACT: The purpose of this study was to examine ways how students negotiate questions, claims, and evidence by analyzing their writing samples developed as results of their discussions and negotiations. Participant 7th grade students were from science classes of the three science teachers from three middle schools located in the second largest city in Korea. Writing samples were collected from two-hundred students from six classes of the three teachers. The writing template that the students used included 1) questions: 'my questions,' 'our group questions,' and 'our class questions,' 2) procedure and data collection, 3) my claims and my evidence, 4) our group claims and our group evidence, 4) what I learned from reading resources, and 5) reflection. Each student used the writing template for each of the two activities, i.e., 'economic development and yellow dust winds (socio-scientific),' and 'igneous rock' or 'desert terrain (science).' The total number of writing samples was four-hundreds. Results of this study indicated that the students revised their questions, claims, and evidence in their writing activity as they were engaged in group and class discussions. Questions, claims, and evidence in group/class levels were more testable, integrated, and based on data than ones in an individual level.

S6A.4.3 Nature of Science (NOS) and On-line Biological Simulations

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

ABSTRACT:

S6A.4.4 Interactions Between Teachers' Existing PCK and Novel Content Knowledge

Emily D. Wischow, Purdue University, emily.wischow@gmail.com

Lynn A. Bryan, Purdue University

George M. Bodner, Purdue University

ABSTRACT: "Learning technologies can be powerful cognitive tools that help teachers' foster inquiry and student learning" (Novak & Krajick, 2004, p. 76). What sort of presence do the Nature of Science (NOS) standards outlined by the American Association for the Advancement of Science (AAAS) (1990) have within these learning technologies, specifically, on-line simulations or activities that focus on biology themes for 6-12th grade? This study is an effort to identify on-line biology simulations that are interactive for the participant; requiring not simply knowledge level understanding, terminology, facts, and principles, but involving processing skills necessary achieve understanding or participate in a task. In short, these resources need to be inquiry-based. As presented within the National Science Standards "[s]cientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" (NRC, 1996, p 26). Particular attention was given to identifying resources that involved at least some level of inquiry. Once identified, the focus of this research was determining whether such activities required the participant to engage in NOS tasks; building knowledge about science as a way of knowing.

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

S6A.5 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.5.1 The Pedagogical Content Knowledge of University Chemistry Professors Teaching Stoichiometry

Kira Padilla, Faculty of Chemistry, UNAM, kira@unam.mx

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Andoni Garritz, Faculty of Chemistry, UNAM

ABSTRACT: Stoichiometry is one of most difficult subjects in Chemistry, however almost all researches have been focused on students' comprehension and on strategies that could be useful to improve students' understanding of this subject. The research goal of this work is to document the Pedagogical Content Knowledge (PCK) on Stoichiometry for a set of university chemistry professors. A frame similar to the one proposed in their Content Representation (CoRe) by Loughran et al. has been constructed by identifying a set of consensual ideas used by professors when they teach Stoichiometry to sophomore chemistry students. The CoRe was applied to four university professors who have, at least, 15 years teaching chemistry at this level. The main ideas identified by professors were substances, percent composition, empirical and molecular formula, balancing chemical equations, and expressions of concentration. The analysis was made taking into account different aspects that are used as tools when Stoichiometry is taught, and have been classified considering the level of explanation and comprehension. Besides, there are not reports that talk about teachers' beliefs and knowledge related to this subject, so this study is interesting because shows what kind of strategies and ways of thinking have chemistry professors on it.

S6A.5.2 High School Preparation for Success in College Science Courses: South Korean Student and Teacher Perspectives

Miyoung Hong, Korea Institute for Curriculum & Evaluation, myhong@kice.re.kr

Nam-Hwa Kang, Oregon State University

Joo-Ah Kim, Yonsei University

ABSTRACT: This study examined high school factors influencing college science learning from the perspectives of college students and high school science teachers. Using a survey created based on focus group interviews, college science majors and high school science teachers rated various factors of high school learning that positively influenced college science learning. Findings suggested that both groups emphasized basic science knowledge and mathematics. However, differences between the two groups were also found in that the students perceived more need to learn about experimentation than the teachers whereas the teachers had a priority in increasing advanced science content. The difference seemed to be related to students' confidence in overcoming lack of content knowledge. Further research was suggested.

S6A.5.3 Comparing Outcomes of Traditional Cookbook Versus Single-Question, Open-Ended Undergraduate Biology Lab

Matthew J. Kloser, Stanford University School of Education, mkloser@stanford.edu

Sara Brownell, Stanford University Biology Department

ABSTRACT: This paper compares the impact of a traditional 'cookbook' undergraduate biology lab course versus a laboratory course that more closely mirrors authentic research by pursuing a single, open-ended, student generated and investigated research question. This paper uses quasi-experimental mixed methods to compare students' interest in scientific and biological research, their self-confidence in executing lab-based tasks, and their lab-course preferences. Twenty students in each condition were matched based on six characteristics. Students in each condition were given a survey at the beginning and end of the course that used Likert-style questions for these constructs. Semi-structured interviews and classroom observations were also conducted. Students in the authentic lab experience were significantly more confident in their ability to execute lab tasks, showed more interest in pursuing further biological research, and at the end of the course preferred lab courses that more closely reflected authentic research.

S6A.5.4 Undergraduate Non-science Majors' Descriptions and Interpretations of a Scientific Data Visualization

Sandra Swenson, CUNY, sswenson@jjay.cuny.edu

ABSTRACT: Professionally developed and freely accessible through the Internet, scientific data maps have great potential for teaching and learning with data in the science classroom. Solving problems or developing ideas while using data maps of Earth phenomena in the science classroom may help students to understand the nature and process of science. Instructors need to understand how students perceive and interpret scientific data visualizations. This study was an in-depth exploration of descriptions and interpretations of topographic and bathymetric data maps made by a

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population of 107 non-science majors at an urban public college. This poster presents one section of research data collected from a larger body of research. The findings suggest that the majority of students interpret data maps by assuming iconicity that was not intended by the map creator and that while most students are able to make some kinds of interpretations of the data maps, often their interpretations are not based upon the actual data the map is representing. This study provided baseline information of student understanding of data maps from which educators may design curriculum for teaching and learning about Earth phenomena.

S6A.5.5 The Relationship Between Epistemological Beliefs and Problem Solving in Physics

Wendi N. Wampler, Purdue University, wamplerw@purdue.edu

Lynn A. Bryan, Purdue University

Mark P. Haugan, Purdue University

ABSTRACT: One of the main goals of many introductory undergraduate physics courses is to develop a sophisticated level of problem solving. However, many students leave these courses with not only serious gaps in their conceptual understanding, but they maintain a novice-like approach to solving problems. The goal of this study is to investigate the relationship between students' personal epistemological beliefs and their problem solving sophistication within the context of a large scale implementation of the Matter & Interactions curriculum (Chabay & Sherwood, 2007), which focuses on modeling as an approach to problem solving. Findings include 5 case examples illustrating three major trends in the relationship between epistemological beliefs and problem solving: a decrease in both appropriate epistemological beliefs and problem solving sophistication; little change in epistemological beliefs and problem solving sophistication throughout the semester; and an increase in both appropriate epistemological beliefs and problem solving sophistication.

S6A.5.6 Preparing Future Scientists and Engineers to Assess the Ethical Implications of Their Work in Nano-Biotechnology

Toth Eva Erdosne, West Virginia University, eva.toth@mail.wvu.edu

Kasi J. Jackson, West Virginia University

Brittany Witherspoon, West Virginia University

ABSTRACT: Public interest in scientific advances is declining [NSF/SEI, 2010] and distrust in business leaders' ability to safely apply nanotechnology related scientific and engineering discoveries is prevalent (Cobb and Macoubrie, 2004). Interest and thrust is especially important during the early phase discoveries novel science such as bio and nanotechnology (jointly referred to as nano-biotechnology), when rapid technological advances provide impetus for everyday applications, however, the associated risks and are not fully known. In these situations scientifically informed public debate, and the communication of scientists with the public are essential. Accordingly, effective instructional methods that help future scientists understand societal and ethical issues relevant to their field, is a critical need for advancement. This paper reports on the results of such integrated course for freshmen science and engineering students that combined the instruction of nanotechnology content and ethical/social perspectives on nano-biotechnology applications to everyday problems. We found that students had a "cautiously optimistic" attitude towards nanotechnology and their reasoning for this attitude noticeably (but not significantly) changed after semester-long classroom instruction. The detailed analysis of students reasoning for their attitude revealed some deep-seated beliefs held by students and informed our further development of the approach.

Strand 6: Science Learning in Informal Contexts

S6A.6 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.6.1 Pedagogic Understandings of Science Summer Camp Leaders

A. Leo Macdonald, St. Francis Xavier University, lxmacdon@stfx.ca

Ann Sherman, University of New Brunswick

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ABSTRACT: This paper describes perspectives of university students who work as camp leaders in two different summer science camp programs. The camps are activity based environments that are popular with children and their parents, however, the experiences of the leaders have yet to be examined. The camps engage children in high energy learning experiences. In addition, the camps provide a good context to investigate the emerging understandings of pedagogy and learning environments from the perspectives of camp leaders who are teaching, often for the first time. As teacher educators, we have, on occasion, identified B.Ed. students who have brought camp experiences with them into B.Ed. program. The focus of this study is on what university students learn as a result of their participation as science camp leaders in a summer program for children. Our research questions include the following: What pedagogic understanding emerge for a university student who acts as a science camp leader? How does acting as a science camp leader impact on a university student's thinking about teaching as a career choice? The perspectives of the science camp leaders can be used to inform the planning of future science camps and the preparation of camp leaders.

S6A.6.2 A Case Study of the Interaction on Science Activities Between Parents and Children in Taiwan

Yi-Ting Cheng, National Changhua University of Education, tonia0213@gmail.com

Huey-Por Chang, National Changhua University of Education

ABSTRACT: Recently there has been an increasing attention given to informal science education. The aim of this article was to investigate parent-child interactions in science-related activities at home and the changing process during the period when a parent participated in a parental science learning group to learn how to be involved in their children's science learning. The researchers set up a parental science learning group in an elementary school from Oct 2008 to Jan 2010. One of the group members volunteered as the study case to investigate the change process in the parent-child interactions style. Data were collected by videotaping. Videotapes were transcribed, translated, checked, and coded. The results revealed that as the time in participation of the parental science learning group increased, the parent-child interaction had changed gradually. More collaboration and inquiry-based interactions were used by parents to interact with their children. This study provided us a better understanding of family interaction styles, so that it could perhaps help us to bridge children's learning at home and at school. While this study has its limitations, it is hoped that it can serve as a basis for further study in getting parents involved in their children's science learning at home.

S6A.6.3 Attitudes towards Science and Technology among General Education Development Students

Casey Fisher, Southern Illinois University Carbondale, mweenechabalengula@excite.com

Vivien M. Chabalengula, Southern Illinois University Carbondale

Frackson Mumba, Southern Illinois University Carbondale

ABSTRACT: The purpose of this study was to examine General Education Development students (GED) students' attitudes towards science and technology. In particular, the study examined students' attitudes in five different constructs: interest in gaining knowledge, concern that science and technology are dangerous, science and technology are beneficial, appropriateness of science and technology for females, and male and females have the same opportunities. Forty seven GED students at a Midwestern community college were asked to complete a questionnaire on attitudes toward science and technology. The results show that participants rated the five constructs in the following descending order: interest, concern, beneficial, appropriateness, and female/male participation. There was no significant difference between males and females. However, students' views of the five constructs showed a significant difference. Further, when comparing the mean of each age group within each construct, there was a noticeable difference. Implications on science teaching and learning have been stated.

S6A.6.4 An Evaluation of the Impact of an Electronic Field Trip on Students' Perceptions of Scientists

Mary E. Varghese, Purdue University, mvarghes@purdue.edu

Kristin A. Hetzel, Purdue University

Omolola A. Adedokun, Purdue University

Loran C. Parker, Purdue University

Wilella D. Burgess, Purdue University

Jamie L. Loizzo, Purdue University

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Joseph P. Robinson, Purdue University

ABSTRACT: This paper describes the impact of an electronic field trip (EFT) on students' perceptions of scientists and science careers. The Draw-a-Scientist-Test and an attitudinal rating scale consisting of items regarding students' attitudes toward science and science careers were used to collect pre- and post- data from 219 seventh grade students. McNemar's Test and paired t-tests were conducted to examine pre-post differences in students' perceptions of science, scientists and science careers. The results suggest that the EFT enhanced students' perceptions of scientists, compared to their pre-participation drawings; students' post-participation drawings contained significantly fewer negative and stereotypical descriptions of scientists. Similarly, there was a significant pre-post increase in students' perceptions that they could become scientists. These results indicate that EFTs are effective in impacting students' perceptions of scientists and science careers and could be viable, cost-efficient alternatives to traditional field trips and classroom visits by scientists.

S6A.6.5 A Youth-Directed Science Café: Impacts on Teen Participants

Susan Foutz, Institute for Learning Innovation, foutz@ilinet.org

Michelle Hall, Science Education Solutions, Inc

Jessica Luke, Institute for Learning Innovation

Michael Mayhew, Synoptic LLC and Science Education Solutions, Inc.

ABSTRACT: Science Cafés are a popular venue for engaging adults in dialogue on issues at the nexus of science and society. A few café programs have been designed specifically for teens. One such program, with a focus on youth leadership and promoting life skills, was the subject of a summative evaluation in Spring 2010. The summative evaluation used a quasi-experimental design with matched control-treatment groups (N=383) to study the impact of the program on 1) attitudes towards science, scientists, and science careers and 2) Positive Youth Development (PYD). The PYD field posits that supportive environments help youth gain social skills, build confidence, and contribute to their community. The evaluation data demonstrated the program positively impacted participants' science-related attitudes; however, the degree to which the program's PYD outcomes were achieved is less conclusive. This analysis suggests PYD may be a difficult set of outcomes to achieve and to measure given the complexity of youth's lives and influences.

Strand 7: Pre-service Science Teacher Education

S6A.7 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.7.1 Teacher Candidates' Exploration of Teaching Science for Social Justice with Elementary Students: Toward a Critical Science Pedagogy

Julie L. Haun-Frank, Old Dominion University, jhaun@odu.edu

Catherine E. Matthews, The University of North Carolina at Greensboro

Melony Allen, The University of North Carolina at Greensboro

ABSTRACT: This qualitative study reports on the learning of four elementary preservice teachers as they plan and implement an electricity unit extension infused with elements of social justice. Ethnographic interviews and classroom observations reveal their struggles and understandings of science, critical pedagogy, and themselves as teachers. Results from this study indicate the need for preservice teachers to have learning experiences that explore science situated within a socio-political context; confront and challenge their cultural models of teaching, and have opportunities to practice with critical pedagogies.

S6A.7.2 Explicit versus Implicit Teaching: Pre-service Elementary Teachers' Peer Teaching Lessons on Inquiry Process Skills

Byoung Sug Kim, Roosevelt University, bkim@roosevelt.edu

Eun Kyung Ko, National-Louis University

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ABSTRACT: The purpose of this study was to explore how pre-service elementary teachers designed and implemented peer teaching lessons when aiming to teach inquiry skills as well as science content knowledge. A total of 90 peer teaching lessons were observed during six different elementary science teaching methods courses over three semesters. Lesson plans, reflective journals on peer teaching practice, observation notes, transcripts of videos, and instructor's feedback were examined in order to see any pattern of pre-service teachers' peer teaching lessons. Results indicated that many pre-service teachers' beliefs about explicit teaching and practice were not necessarily aligned with how they were taught during the methods courses. Most of pre-service teachers addressed that if students were involved in any kinds of hands-on activity, they taught inquiry skills explicitly. It appears that the nature of explicit teaching of inquiry skills is much more complex since it requires adequate understanding of inquiry skills, inquiry-based teaching, and "explicit-reflective" teaching of inquiry skills. Therefore, it is necessary for science educators to guide pre-service teachers about explicit teaching by scaffolding explicit-reflective teaching of inquiry skills.

S6A.7.3 A Further Exploration of Factors Related to Acceptance of Evolutionary Theory among Turkish Preservice Biology Teachers

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

Irfan Yilmaz, Dokuz Eylul University, Izmir TURKEY

Faruk Cetin, Dokuz Eylul University, Izmir TURKEY

ABSTRACT: This study examined the acceptance of evolutionary theory among Turkish preservice biology teachers. In this study, we explored the nature of relationship between acceptance of evolutionary theory and potential predictors of acceptance such as understanding of evolutionary theory, mother's education level, thinking dispositions, religious orientation, epistemological beliefs, biology self-efficacy beliefs, and years spent in biology education program. We conducted a sequential multiple regression analysis using acceptance of evolutionary theory as the dependent variable, and understanding of evolutionary theory, mother's education level, thinking dispositions, and religious orientation as predictors. Epistemological beliefs, biology self-efficacy beliefs, and years spent in the biology education program were not correlated with the acceptance of evolutionary theory. Therefore, these predictors were not included in the regression analysis. Understanding of evolutionary theory, mother's education level, thinking dispositions, and religious orientation together accounted for 50 % of variance in acceptance of evolutionary theory.

S6A.7.4 Using Problems of Practice to Approximate Teaching in a Pre-service Methods Course

David J. Grueber, Wayne State University, grueber@wayne.edu

Nonye M. Alozie, Wayne State University

Mary O. Dereski, Wayne State University

ABSTRACT: This is an action research study of a pre-service methods course. The instructional strategies of the methods course are centered on the use of lesson planning that incorporates problems of teaching practice. This study raises questions about what pre-service teachers learn in a methods course, and the effect of teaching strategies utilized in the methods course.

S6A.7.5 Examining Progress in Recruitment, Preparation and Induction of Pre-service Teachers in the NSF Noyce Program

Ann M.L. Cavallo, The University of Texas at Arlington, cavallo@uta.edu

Gregory Hale, The University of Texas at Arlington

James Epperson, The University of Texas at Arlington

Ramon Lopez, The University of Texas at Arlington

ABSTRACT: The University of Texas at Arlington's NSF Robert Noyce Scholarship Program for Science and Mathematics Teachers is designed to certify new teachers who are qualified and competent to teach in the Dallas, Arlington, and Fort Worth Independent School Districts. Our program is a collaborative effort among the University of Texas at Arlington's (UTA) College of Education and Health Professions and College of Science and these surrounding urban school districts. Objectives of this program are to: 1) increase the numbers of qualified science and mathematics teachers, 2) ensure pre-service teachers engage in a quality educational program, and 3) promote successful induction and retention in the

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teaching profession. This paper reports the first two years of progress in achieving these objectives in recruiting, preparing and inducting qualified science and mathematics teachers for our partner urban school districts.

S6A.7.6 A Co-er and Pap-ers Unit on Electricity for Preservice and In-service Elementary Teachers

Saiqa Azam, University of Calgary, 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, a model was proposed proposes for pre-service and in-service elementary to help develop science PCK of generalist elementary teachers (Azam, 2010). Based on this model, present paper describes a unit designed for a generalist pre-service elementary science teacher education to develop science PCK for teaching electricity at elementary level. The Unit can also be used for professional development of in-service elementary teachers.

S6A.7.7 Investigating Teachers' Understandings of the Nature of Science (NOS) and Developing a NOS Assessment Questionnaire

Eunmi Yang, Stonehill College, eyang@stonehill.edu

Michelle Jaques, Stonehill College

Virginia Epps, University of Wisconsin-Whitewater

ABSTRACT: Teachers' views of the Nature of Science (NOS) are significant because they influence how teachers teach science. While essays and interviews provide detailed and unbiased data, needs for practical instruments for large scale studies and quick surveys still exist. This study describes the initial processes of developing and evaluating a questionnaire. Twenty eight 5-point Likert-scale questions were developed based on recently established concepts of the NOS and were administered to 112 preservice teachers enrolled in semester-long science methods courses towards the end of each semester. The results supported the fact that long-lasting NOS misconceptions can be identified by multiple choice questions as accurately as they can by essays and interviews. Descriptive statistics, including percentage agreement, showed many preservice teachers still held onto misconceptions previously identified by essays and interviews. Accepting experimental design as the only science method, confusing between correlational and causal relationships, perceiving evidences as "proving" instead of "supporting," admitting hierarchical order between laws and theories, and believing in the scientific method were among the strongest misconceptions. Related issues with the use of Likert scale questions and specific words/phrases are discussed based on results from descriptive statistics, internal consistency tests, and Repeated Measure ANOVA on NOS-Consistent and NOS-Inconsistent items.

S6A.7.8 Developing PCK Beyond the Methods Course: Exploring the Use of Science Specific Mentors with Elementary Student Teachers

Meredith A. Park Rogers, Indiana University - Bloomington, mparkrog@indiana.edu

ABSTRACT: This study explores the use of a science specific mentor for further development of beginning elementary teachers' PCK for science teaching during their student teaching. Data collected for this case study (Diane) included two semi-structured interviews, excerpts from the participant's teaching journal, classroom observations, and weekly discussions/debriefings between the mentor and mentee. In response to the research questions the findings were: 1) Prior to her student teaching, Diane was most concerned with how to use what she learns about her students understanding and adjust her instruction accordingly. 2) Diane viewed both her classroom teacher mentors and the science specific mentor as key supports to her learning but viewed the kind of support offered as different. 3) Diane believed she would not have obtained the success she did in teaching science if it were not for the science specific mentor challenging her thinking. 4) Instances of further PCK development for Diane were noted with respect to each

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area of her science teaching knowledge. Implications of the fruitfulness and potential improvements for this approach based on our experience are discussed.

S6A.7.9 Promoting an Argument Structure in Elementary School Classrooms

Reizelie Barreto-Espino, Towson University, rbarreto@towson.edu

Carla Zembal-Saul, The Pennsylvania State University

ABSTRACT: Teacher education is an utterly important aspect in our ceasing mission of creating scientifically literate citizens. Nonetheless, teacher education faces challenges in sustaining coherent frameworks within and across components of teacher education program that promote teaching science as argument. A further problem is our insufficient knowledge in science education in regards to prospective elementary teachers' understanding and adoption of science instruction with an emphasis on teaching science as argument. The study investigated the research question: How do prospective elementary teachers appropriate components of teaching science as argument during student teaching when presented to a teaching science as argument framework? Findings demonstrated that scaffolded protocols, grounded in a coherent framework, positively influenced participants' attention to enabling students to construct evidence-based explanations and attend to an argument structure during science planning and teaching. In addition, participants developed images and beliefs of refined aspects of teaching science in elementary schools. These findings are relevant because some scholars have argued that elementary school teachers struggle to adopt and enact sophisticated views of science teaching.

S6A.7.10 Contrast of the Science Teaching Practices of Two Pre-service Early Childhood Educators

Deirdre Englehart, UCF Daytona Campus, dengleha@mail.ucf.edu

ABSTRACT: Pre-service need time and experiences to support their teaching practices as they move from teaching during internship experiences into teaching in their own classroom. Many early childhood teachers do not have a strong background in science to support inquiry-teaching practices. Teachers are more likely to teach inquiry science when they have experienced it previously and when they have a good understanding of science content. This case study research investigated the teaching practices of two pre-service early childhood educators during their junior and senior internship experiences while teaching science. Both pre-service teachers had a similar program of study and both used educative curriculum materials during their senior internship teaching experiences to teach science. The Views of Science Inquiry instrument was used at the beginning and end of the research along with observations and interviews to explore their science teaching practices. Results of this research confirm that although teachers may have access to the same curriculum, their own background, experiences and beliefs influence their classroom practices especially regarding the implementation of scientific inquiry. Educative curriculum materials supported the teachers in teaching through inquiry practices but the extent to which they integrated inquiry was based upon their own beliefs and understandings of teaching.

Strand 8: In-service Science Teacher Education

S6A.8 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.8.1 Professional Identity Development of Beginning Elementary Teachers of Science: A Comparative Case Study

Phyllis Katz, University of Maryland, pkatz15@gmail.com

J. Randy McGinnis, University of Maryland

Kelly Riedinger, University of Maryland

Scott J. Dantley, Coppin State University

Gili Marbach-Ad, University of Maryland

Rebecca Pease, University of Maryland

Amy Dai, University of Maryland

Lori Jusiewicz, University of Maryland

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ABSTRACT: We investigated beginning teachers' professional identity development as elementary teachers of science. We used a comparative case study. Our sample included: four [name removed] graduates (treatment) and two [name removed] elementary education graduates (comparison). [name removed] was a National Science Foundation funded elementary science teacher preparation project that included a collaborative partnership among a Historically Black Institution, a Primarily White Institution, and an informal science education program. Program innovations included: an active learning science content course, an informal science education internship, and an innovative elementary science methods course. We used complementary methods of data collection and analysis. Data collection included pre-post responses to a survey, drawing prompts and interviews. Data analysis was informed by recommendations made by the NRC (2007; 2009). All cases demonstrated changes in a targeted direction on survey items and in drawings. Our participants who experienced the informal afterschool science education internship evidenced greater sophistication in how they talked about themselves as teachers and learners of science. The inclusion of informal science education in formal science teacher preparation may encourage beginning teachers of science to develop professional identities that support an important recommendation (i.e., excitement, interest, and motivation) in the latest reform document (NRC, 2009).

S6A.8.2 Using Lesson Study to Understand How Elementary Science Teachers Translate Social Constructivist Learning Theory into Practice

Apisata Juntaraprasert, Kasetsart University, Bangkok, Thailand, japisata@hotmail.com

Vantipa Roadrangka, Kasetsart University, Bangkok, Thailand

Deborah J. Tippins, The University of Georgia, Athens, GA

ABSTRACT: This interpretive case study examines three elementary teachers' understandings and practices with respect to Social Constructivist Learning Theory. The study took place in the context of a Lesson Study professional development experience consisting of a two-day workshop, curriculum planning and practice in the classroom. Throughout the teacher professional development experience, written reactions to Social Constructivist Learning Theory vignettes, individual interviews, classroom observations, and teachers' lesson plans and focus group discussions provided the sources of data. The analysis illustrates some of the dynamics and promise of teacher change spurred by the teacher professional development experience. Teachers' understanding and practice gradually changed from traditional teaching to practices more consistent with Social Constructivism, although there was not a complete shift. The three case teachers showed that their understandings of Social Constructivist Learning Theory influenced their translation into practice in terms of science lesson plans and pedagogical strategies. In terms of change and growth, opportunities for collaboration and reflection in the professional development experience supported teachers in constructing their own knowledge and translating their understandings of Social Constructivist Learning Theory into practice. The implications of this study suggest that teachers can become curriculum makers rather than technicians which has significant value in terms of making decisions concerning the design of classroom environments.

S6A.8.3 Comparison of Science, Social Studies and Ethics Teachers' Understanding

Jungsook Yoo, Ewha Womans University, jsyoo@ewhain.net

Sung-Youn Choi, Ewha Womans University

Hyunju Lee, Ewha Womans University

ABSTRACT: In order to get a larger perspective on teaching SSI, we explored teachers in the subject of social studies and ethics, as well as science, who have been addressing SSI in their classes. SSI is inter-disciplinary by its nature and mostly has been addressed in those three subject areas. It is assumed that teachers in social studies and ethics not only have different subject matter background, but also have different social awareness and worldviews which are the "important factors affecting their teaching practice and personal and professional growth and development" (Witz et al., 2001, p. 198). The guiding research question of the study is as follows: what are the commonalities and differences of teachers in science, social studies and ethics in terms of their motivation for teaching SSI, understanding of SSI, and approaches to SSI?

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S6A.8.4 Teachers' Experiences on Inquiry Teaching Learning: From the Perceptions of 10 Experienced Junior-high Science Teachers

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Hsiao-Lin Tuan, National Changhua University of Education

Chi-Chin Chin, National Taichung University

ABSTRACT: The aim of this study is to describe the perceptions of 10 experienced junior-high science teachers on their learning experiences of inquiry teaching. Data is collected from Inquiry Teaching Efficacy Questionnaire and semi-structured interview, and the text is analyzed according to grounded theory method. The findings indicate that teachers possess rationality viewpoints on science and science teaching before their teaching change. By the initiation from their high-school learning experiences and their academic science teaching learning, they shift their teaching beliefs to naturalism approach and then begin to implement inquiry teaching. In addition, because they comprehend their professional development and students' growth gradually, they are willing to persist to implement inquiry teaching even though they face diverse obstacle. This study also indicate three critical factors that effect success of teachers' professional development, there are teachers' reflection on teaching, beliefs on inquiry teaching, and scaffolding from research group. Suggestions for teacher educators and research implications are discussed.

S6A.8.5 Navigating with Content Driven Literacy in the Secondary School Classroom: A Case Study of Three Teachers Approaches from Their Second Year Teaching

Jessica F. Riccio, Teachers College, Columbia University, riccio@tc.edu

ABSTRACT: The concept of content area literacy is not new. The challenges that teacher educators in science face surrounding the need to teach it are many. Besides knowing the science content, new teachers have to learn how to teach generic strategies, discipline specific strategies, domain knowledge and dispositions of literacy. As the texts change, so do the tasks for the students and for the teacher. In an effort to make sense of these tasks, teachers must understand the ways, and strategies to elicit and assess prior knowledge, build vocabulary, and monitor comprehension. Generic literacy strategies, though based in research must be adapted for successful use in the science classroom. Teacher educators can partner with new inservice teachers to provide an essential link between preparation and practice. This interactive poster paper will highlight three second year science teachers growth from preservice to inservice teachers in adapting literacy tasks to the needs of science learners.

S6A.8.6 Professional Development Program Boosts Science Teaching Practices among Head-Start Teachers on an American-Indian Reservation

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

Gillian H. Roehrig, University of Minnesota

Ann Mogush-Mason, University of Minnesota

Barb Murphy, University of Minnesota

Stephan Carlson, University of Minnesota

ABSTRACT: This article presents the results of Ah Neen Dush, a unique science professional development program for Head Start teachers on an American Indian Reservation. The goal of the program is to support early childhood teachers in developing science curricula while emphasizing Ojibwe cultural themes. Specifically, the article portrays the process of change in the beliefs and practices of the teachers during two years of the program. Through analysis of teachers' reflections, surveys and interviews, as well as analysis of classroom observations, the authors point at awareness toward science opportunities as the first step in change of practices. Additional steps leading to enhanced science teaching practices were observed as teachers increased questioning and interactions with students and adopted workshops' strategies and vocabulary. Classroom observations were conducted using CLASS (Classroom assessment Scoring System), a tool used to evaluate classroom interactions. The authors discuss challenges that this professional development program proposed - such as working with diverse group of teachers, incorporating technology as means

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of communication, and weaving together cultural themes and scientific processes - and present implications for other early childhood science professional development programs developers about overcoming such challenges.

S6A.8.7 Impact of School Experiences on Beliefs about the Nature of Science: Two Case Studies on Persisting Secondary Science Teachers

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Irasema B. Ortega, Arizona State University

Julie A. Luft, Arizona State University

Jonah B. Firestone, Arizona State University

Krista L. Adams, Arizona State University

ABSTRACT: Beliefs have been found to be a strong influence on decisions and actions of a particular individual and can be an indicator of teacher choices made in the classroom. One means to gain greater understanding into teacher decisions is by studying teacher beliefs. In this study, two beginning secondary science teachers were selected as instrumental cases to illustrate the factors that impacted their beliefs about the Nature of Science (NOS), and in turn, how these beliefs impacted how they incorporated the NOS into their instruction. After a five-year period, it was found that while both teachers' personal school experiences impacted their beliefs about the NOS, they differed in how each incorporated the NOS in their instruction. Bruce was unable to incorporate the NOS as a socially constructed endeavor that is theory-laden due to curriculum and time constraints, while Jared was able to teach science as a linear process focused on confirming expected results. The results presented in this study provide insight to those who work with science teachers, such as NARST members that are involved in science teacher preparation and those involved in creating and implementing professional development opportunities for in-service science teachers.

Strand 9: Reflective Practice

S6A.9 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.9.1 A Story About How A Novice Science Teacher Became An Expert Science Teacher In Taiwan

Hsin-Jung Dai, Pingtung County Chung-Hsiao Elementary School, sir641286@yahoo.com.tw

Jing-Ru Wang, National Pingtung University of Education

ABSTRACT: This paper presents a self-report about how a classroom teacher with non-science major became an expert science teacher. At early stage, the author1 explained the "science knowledge" clearly to her students, without knowing pedagogical content knowledge (PCK). After she had an opportunity participating in a research project and discussing with university professors and This paper presents a self-report about how a classroom teacher with non-science major became an expert science teacher. At early stage, the author1 explained the "science knowledge" clearly to her students, without knowing pedagogical content knowledge (PCK). After she had an opportunity participating in a research project and discussing with university professors and team members on integrating mathematical reasoning into science teaching. After that project, the author1 joined a professional community project with university professors and science teachers with science-major for six years. During this period, she explored how to teach science using 5E model through designing units of science course with university professors and school science teachers. During that time, she learned how to observe classroom teaching by others teachers, constantly reflected on the effects of her teaching on students' learning outcomes and students' responses to her teaching. In addition, she also mentored many pre-service teachers how to teach science. She accumulated her experiences from learning to teach to mentoring pre-service teachers. Her practical knowledge of teaching science provides significant implications for science educators and policy makers on how to improve science teacher professional development program.

S6A.9.2 Engaging Urban Pre-service Teachers in Meaningful Reflective Practices Through Video Analysis and Peer Feedback

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Mercy Ogunsola-Bandele, Adamawa State University, Adamawa Nigeria

ABSTRACT: The current study explored the use of video as a reflective tool as eleven secondary science pre-service teachers worked in community of learning model to reflect on their teaching practices. The video analysis process resulted in the production of a five page personal reflection that was later revised based on peer feedback and a quick write that described credential candidates' opinion about the collaborative video analysis process. Two phases of analysis were involved, a personal video analysis and reflection, and a collaborative reflection by the CCs as they worked as community of learners to observe their peer's authentic experiences in the classroom repeatedly in their videos of lessons they taught during their student teaching. Based on this, CCs provided critical feedback to each other about the depictions of the video. Results of the collaborative reflective video analysis showed that CCs improved their reflective skills and expressed general satisfaction and willingness to change their teaching practices based on the collaborative support they received from their peers throughout the video analysis process. It was recommended that science teacher educators consider using this strategy in their pre-service classrooms to better prepare pre-service teacher to face future challenges of the real classrooms.

S6A.9.3 The Influence of Collaborative Action Research on Chemistry Teacher Beliefs

Katrin Vaino, University of Tartu, katrin.vaino@ut.ee

Jack Holbrook, University of Tartu

ABSTRACT: The main goal of the current study was to explore the influence of action research on decreasing teacher constraints within a collaborative project on teacher beliefs. The beliefs were a focus in implementing a new teaching approach geared to enhance students' scientific and technological literacy (STL). In order to examine chemistry teachers' beliefs towards STL teaching, case studies were constructed for five teachers. Teacher beliefs were analyzed based on Ajzen's Theory of Planned Behaviour by looking at teacher's (a) attitude towards implementing STL modules, (b) perceived normative prescriptions, and (c) behavioural control. In the second year of the study, a collaborative action research project was initiated and developed in order to help teachers to minimise or overcome initially perceived constraints when implementing STL modules in their classroom. The processes of teacher change and the course of the project were investigated by teacher interview, teacher informal commentaries, and workshop. The close cooperation in the format of collaborative action research, especially teacher group reflections and dissemination of STL modules to the wider audience turned out to be an effective approach for teacher professional development. The formation of teachers' positive beliefs towards the STL approach increased continuously, although its extent varied depending on the teacher.

Strand 10: Curriculum, Evaluation, and Assessment

S6A.10 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.10.1 Using Many Facet Rasch Measurement to Evaluate Judges, Examinees, and Items: An Example Using the ESTAM

Jeffery S. Townsend, Eastern Kentucky University, scott.townsend@eku.edu

William J. Boone, Miami University

ABSTRACT: This study uses a culminating assignment from a science methods course for preservice elementary teachers. The classroom project consisted of 150 preservice teachers (judges) evaluating videotaped science lessons of five inservice teachers (examinees) utilizing items from the Elementary Science Teaching Analysis Matrix (ESTAM). The presentation will share the methods course assignment, along with the methodologies and results of the study, as examples as a call for the implementation of many facet Rasch measurement (MFRM) techniques in science education. MFRM should be used any time data are collected involving judges to score examinee's actions, performance or products using some sort of scoring rubric. Instead of simply emphasizing the need for inter-rater reliability between judges, many facet Rasch measurement emphasizes the need for individual judges to be consistent in their own scoring

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so adjustments and awareness can be made regarding judge strictness, leniency, or consistency. Suggestions will be shared regarding several uses of many facet Rasch measurement techniques in science education.

S6A.10.2 Discussion as a Meaning-making Practice: Variations in the Enactment of Discussions in Science Classrooms

Monica (Mon-Lin) Ko, Northwestern University, monlinko2008@u.northwestern.edu

Brian J. Reiser, Northwestern University

ABSTRACT: Engaging students in rich scientific discourse is a critical component of reforming science instruction. In this paper, we explore the potential variation in how teachers enact discussions designed to help students make sense of scientific phenomena. This study analyzed the teacher-student discourse in two classrooms, taught by two different middle school science teachers at the same school while they used the same inquiry-based curriculum. We found that the two teachers emphasized different meaning making practices while engaging in discussions with their students. While one teacher utilized the discussion to generate a description of the phenomenon, the discourse in the other classroom allowed students to generate an explanation for the phenomenon and make connections to a larger driving question. We argue that these differences may be due to how each teacher makes sense of the curriculum materials, and that these discussions may result in varying degrees of support of student thinking and learning.

S6A.10.3 Research-Based Multidisciplinary Science Instructional Materials for Grade 8: A Tool to Promote Equity?

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Janet Carlson, BSCS

Scotter Pamela Van, BSCS

Betty Stennett, BSCS

ABSTRACT: This study examines the extent to which research-based multidisciplinary science instructional materials for Grade 8 can mitigate the expansion of achievement gaps by student demographic variables. We conducted a feasibility test of newly developed materials with 25 teachers across the United States. Results show that while the instructional materials appear to be highly effective at promoting achievement for all groups of students, achievement gaps by student demographic variables widened for students using two out of three units. Using an integrated theoretical framework proposed by Grumet and Stone (2000), we consider the characteristics of materials that should promote equity in the classroom. We analyze the key features of the materials in question, and provide recommendations for how to redirect the emphasis of the key features to better serve all students. This study has implications for emphasizing instructional-materials review and selection during pre-service teacher coursework.

S6A.10.4 Using the Force Concept Inventory to Measure High School Students' Learning Progression of Forces

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Ling L. Liang, La Salle University

Xiufeng Liu, University at Buffalo

ABSTRACT: The present paper analyzes the validity of the Force Concept Inventory (FCI; Hestenes, Wells, & Swackhamer, 1992) as a measure of learning progressions. It builds on current work on a learning progression of the concept of force by analyzing the FCI item responses using the proposed framework of Steedle and Shavelson (2009). The Rasch measurement model was used to analyze and scale the responses using a rating-scale model. The results indicate that there are distinct, latent classes of students that correspond to the proposed levels, 0 through 4. However, the distinctions among student scores among levels 0 through 2 were very small. Furthermore, the FCI showed poor fit when coded as a rating scale. This suggests that the FCI may require revision before being appropriate for measuring learning progressions, and that the learning progression may need further refinement of the definitions at the lower levels of the progression.

S6A.10.5 Understanding the Impact of Formative Assessment Strategies on First Year University Students' Conceptual Understanding of Chemical Concepts

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Aybuke Pabuccu, Abant Izzet Baysal University, Bolu, Turkey

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ABSTRACT: This study investigated the effects of formative assessment strategies on students' conceptual understanding in a freshmen college chemistry course in Turkey. Our sample consists of 96 students; 27 males, 69 females. The formative assessment strategies were used throughout the course. The findings reveal that the formative assessment strategies used in this study led to significant learning gains for students. Our discussion focuses on implications for college science teaching and ways to change the culture of teaching in college science classrooms.

S6A.10.6 The Development of Practical Course Work for Prospective Science Teachers' Pedagogical Content Knowledge

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ABSTRACT: Researcher has suggested that PCK is crucial to improve teacher or student ability of teaching. It also requires specific content topic, and knowledge of student's misconceptions of the specific topic. However to develop PCK course work is difficult. No course work on the ion concept of PCK are current available. This study develops the course work on this topic to promote prospective science teachers' PCK, and test that measure the student's ability of this topic. For these objectives, first, pre-test, post-test and delayed-test were conducted. Second, we compare the delayed test results between student who took this course and who did not take. Third, we did interview students how they took this course work. Fourth, we compare the delayed-test and test result of college chemistry to see the correlation. Lastly, delayed test results were analyzed by Rasch model to develop measurement instrument. Four points were revealed as follows: (1) If student did not learn ion learning from this course work, they could not obtain an adequate knowledge of this domain. (2) Although there was a correlation between the test result of science content and this course work, it was not strong. (3) Most students thought this course work is necessary, when they become a teacher. (4) Although most students said that they had learned the content knowledge (the conception of ion), they learned not only the method how to teach this specific domain, but also learned ion conception. Because they found they had misconception on this domain. Consequently, this course work could be a PCK program of ion at grade 9 levels for prospective teachers. We also develop measurement instrument of PCK of ion.

S6A.10.7 Global Sustainability and Public Understanding of Science: Using Socioscientific Issues to Assess Environmental Literacy

Tali Tal, Technion, rtal@technion.ac.il

Anat Aabramovitch, Technion

ABSTRACT: In the study, we developed socioscientific issues (SSI) to assess high school students' environmental literacy (EL), based on the assumption that EL should be assessed in relevant and meaningful context, and that EL reflects complex thinking about environmental and social issues. Based on the research literature, we developed a scoring rubric that was used to assess students who major in environmental sciences who participated in an outdoor learning unit that engage the students in studying three different settings. Our findings indicate the students improved significantly from the pre-test that focused on a bottled water plant in the desert to the post-test that focused on a debate over a cross country toll highway. The dimensions in which the students improved were knowledge, skills, awareness, behavior and values. Overall, using Roth (1992) terminology, they shifted from nominal (basic) literacy to functional (medium), with 30% reaching the operational level (high). We suggest that SSI can improve learning and assessment in environmental as well as in science education and can add a meaningful and contextual method to assess EL.

S6A.10.8 Surveying Ocean Literacy: Instrument Development and Validation

Joo Chung, Lawrence Hall of Science University of California, Berkeley

Kristin Nagy Catz, University of California, Berkeley, knc@berkeley.edu

Rena Dorph, Lawrence Hall of Science University of California, Berkeley

ABSTRACT: Earth's largest ecosystem, the ocean, is in dire need of attention and understanding. So far, ocean science has received little attention in the classroom. Concepts about the ocean are infrequently taught in K-12 schools, and rarely appear in K-12 curriculum, textbooks, assessments, or standards (McManus et al., 2000). We developed a measure that can be used to measure Ocean Literacy in adults and youth (12-18 years old). We have piloted the survey instrument which measures four 4 dimensions: (1) exposure to ocean and marine experiences, (2) knowledge of the

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principles and fundamental Concepts, (3) attitudes and beliefs about the ocean and about marine life, and (4) behaviors related to the ocean and to marine life. The results of the analysis suggest that the Exposure, Knowledge and Behavior sections of the Ocean Literacy Index (OLI) are satisfactorily fitting the Rasch model. However, the Attitudes and Beliefs portion was found to exhibit some problematic characteristics that will be addressed in future iterations. Examining the item parameters for the Attitudes and Belief section revealed a significant amount of redundancy. In particular, very few items were very high or very low in the item parameter distribution. Future iterations will examine the effect of including new items to the Attitudes and Beliefs section of the OLI.

S6A.10.9 Integrating Science Simulations into Curricula and Assessment Systems

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Barbara C. Buckley, WestEd

ABSTRACT: A collaboration of several research institutions and state education agencies developed instructional modules and assessments that focus on several topics in science, including: atoms & molecules, climate, ecosystems, and force & motion. For each topic, instructional modules and curriculum-embedded assessments that provide opportunities for formative assessment, reflection activities that reinforce and extend the targeted concepts and inquiry skills, and benchmark assessments have been developed. The embedded assessments provide immediate feedback and coaching; paired with reflection activities, data from the assessments enable teachers to address the need for formative assessment. The components for each topic are developed around storylines that provide roles for students to engage in the tasks. The components use the interactive simulations to address content that is difficult to present in classroom instruction, and that is not typically addressed adequately by traditional assessments. The reflection activities and summative assessments also address students' abilities to transfer their understanding to novel contexts. The components have been evaluated in cognitive laboratories and in classroom pilots with teachers and students in several states. Data from classroom pilots provide evidence of the technical quality of the components, and the feasibility and utility of their integration into curricula and balanced, multilevel assessment systems.

S6A.10.10 How Do Elementary School Science Textbooks Present The Nature Of Science?

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Julie Vowell, University of Houston

Young Lee, University of Houston

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

Strand 11: Cultural, Social, and Gender Issues

S6A.11 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.11.1 Connecting School Science Learning with At-home Activities: Documenting Learning through a Science Backpack Program

Carrie Tzou, University of Washington Bothell, tzouct@u.washington.edu

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Elyse Litvack, Maple Elementary School, Seattle School District

ABSTRACT: A growing body of research in out-of-school science learning is focusing on the rich and varied ways in which youth learn science outside of school, including habits of mind, motivation, and identities as scientists (Bell et al, 2009). The goal of this project was to design, implement, and study a science backpack program that connects elementary school science learning with science activities done at home with families. Specifically, we designed mini science kits that contain simple materials, directions, and ideas for conducting scientific investigations at home that connect conceptually to science being learned at school. This project asks the following questions: (1) how are the backpacks used by students and their families to extend learning of key scientific concepts from the school curriculum? (2) What is the nature of the learning that occurs both by students and their families when they engage with the backpacks? (3) What design principles can be generalized from this pilot study to expand this program across the elementary grade levels to more effectively connect home and school science learning? Preliminary analyses indicate that the backpack activities became opportunities for families to interact around science learning together by leveraging cultural and linguistic resources existing in the home.

S6A.11.2 The Intersection of Ethnicity and Gender in STEM Undergraduate Experiences: A Case Study

Roxanne Hughes, Florida State University, hughes@magnet.fsu.edu

ABSTRACT: This case study focuses on Rosa, a Latina college senior. The paper outlines Rosa's life history as it relates to her decision to pursue graduate school in physiology. Rosa's story highlights the added issues that ethnicity and gender can play in individual's ability to see themselves as members of the community of science. The intersection of ethnicity and gender can often lead women to opt out of male dominated STEM fields. Consequently, Rosa's story offers a closer look at how she overcame the stereotypes and discrimination she encountered in her own experiences at the high school and college level. This story adds to the research that identifies ways to improve Latina women's experiences in STEM fields.

S6A.11.3 Comparison of 15-Years Old and Upper-Secondary Schools Students' Occupational Expectations and Extrinsic Motivation to Learn Science

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Maarja Lond

Priit Reiska

ABSTRACT: The research is focused on contradiction between different language of instruction upper-secondary schools students' awareness on science-related careers, instrumental and future-oriented motivation to learn science. The results will be compared against PISA 2006 results. PISA 2006 provided two indices to measure 15-years old students extrinsic motivation to learn science and two indices to measure students' expectations to pursue a scientific career. Estonia was one of the highest-performing country in PISA 2006, but 15-years old students reported a below average level of extrinsic motivation and occupational expectations. There was a significant difference in extrinsic motivation and expectations on science-related careers between Estonian and Russian language of instruction upper-secondary school students. Russian students had higher extrinsic motivation and they reported more that they will work in a science-related career. The upper-secondary schools students' labor market expectations were generally lower than 15-years old students aspirations and the older students believed that their secondary education does not provide them with relevant job skills. Both language instruction school students agreed with usefulness of schooling for as preparation for science related careers. The males and females from upper-secondary schools reported similar level of labor market expectations.

S6A.11.4 Story-telling and Writing: A Platform for Cultural Exchange between Science and Everyday Ways of Knowing

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Barbara A. Crawford, Cornell University

ABSTRACT: This paper reports on the unexpected space of story-telling as a platform for cultural exchange between science, everyday ways of knowing, and the imaginary for 5th grade English language learning (ELL) students from Latino backgrounds. The implementation of the Fossil Finders project, an authentic investigation in collaboration with

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scientists, provided the context for students to be involved in the activities of science and in learning about nature of science, or opportunities to experience scientific culture. The project also included literacy learning activities, which were integrated into the instructional approach by the teacher and a classroom visit by a scientist, based on student requests. Together, the literacy-based activities and classroom visit by the scientist, contextualized by the authentic investigation, provided the space for story-writing and telling to bring together every day and scientific ways of knowing. In this way, the project demonstrates how the use of stories may equip students to mediate between the every life, school, and scientific understandings.

S6A.11.5 Navigating Inquiry and Academic Language in Classrooms with ELLs: A Longitudinal Study of two Beginning Secondary Science Teachers

Irasema B. Ortega, Arizona State University, iortegac@asu.edu

Sissy S. Wong, University of Houston

Sarah Newcomer, Arizona State University

Jonah B. Firestone, Arizona State University

Krista L. Adams, Arizona State University

Julie A. Luft, Arizona State University

ABSTRACT: This longitudinal qualitative cross case analysis describes the learning trajectory of two beginning high school science teachers who taught high numbers of English language learners (ELLs). We followed the participants for the initial three years of teaching. The teachers took part in an induction program focused on the development of inquiry practices. The data examined for this study consisted of semi-structured interviews, PCK interviews, classroom observations and teacher artifacts. The findings indicate that the science specific induction program helped the participants understand and implement inquiry science. In addition, district and university sponsored methods for teaching ELLs professional development helped build the participants' capacity to incorporate academic language skills into their repertoire of practices. Teachers learned how to integrate inquiry science and academic language development on their own. Both teachers experienced different barriers to the implementation of inquiry, from high stakes testing to added responsibilities and large classroom sizes. The findings of this study have implications for those involved in retaining and supporting quality science teachers in urban schools. Keywords: Beginning science teachers, urban schools, English language learners, inquiry, inquiry, induction, contextual factors.

S6A.11.6 Grade Nine Students' Interests towards Learning Science at School and its Relationship with their Future Career Choices

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Miia Rannikmäe, University of Tartu, Estonia

ABSTRACT: The main purpose of the current research was to specify and categorise students' learning interests and to find out whether there are significant correlations between students interest and their future career choices. The data for the study were gathered from 584 students (313 girls and 271 boys) from 22 schools answering to the written questionnaire. Although the instrument consisted of four sections, the current study used only two domains for analysis - students' interests towards science learning and students' future career choices. All the items were given on a 4-point Likert-type scale. The confirmatory factor analysis was carried out in order to group the items. Outcomes showed that it was possible to categorise grade nine students' interests towards science learning into 15 different factors; students' future career choices into 5 factors. It was possible to group interest related factors into three groups, based on science context: everyday life related topics, theoretical science topics and global & social issues related topics. Results showed several statistically significant positive correlations between students' interests and their future career choices. These were: between students' interest towards technological equipment and technology & experimentation related future career, between pseudoscience and the self-development area and also between environmental issues and sociality & education related career.

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Strand 12: Educational Technology

S6A.12 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.12.1 Crystal Island-Uncharted Discovery: An Intelligent Game-based Learning Environment

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Bradford Mott, North Carolina State University

Hiller Spires, North Carolina State University

John Neitfeld, North Carolina State University

Marc Russo, North Carolina State University

Jonathan Rowe, North Carolina State University

ABSTRACT: Despite growing interest in the transformative potential of game-based learning environments little is known about the true cognitive impact of educational games. The idea of appropriating high-end commercial game engines for educational purposes is appealing, but in the absence of pedagogically adaptive systems, resulting games, while entertaining, may not lead to improved learning of targeted content. This interactive poster session will report on the Year 2 activities and results of a four-year federally funded research study of an intelligent game-based environment designed to promote problem solving in science learning for upper elementary students (5th grade). Crystal Island: Uncharted Discovery is a cross-disciplinary effort guided by the principles and attributes of design-based research (DBR)/design-experiment methodologies. It brings together researchers from computer science, science education, and educational psychology and teams them with a lead teacher cadre, digital artists, and elementary students to build and systematically study the cognitive impact of collaboration and instructional scaffolding in 3D storyworlds. The poster presentation will highlight the development and field testing the first “playable” iteration of the CRYSTAL ISLAND, our continuing analysis of the targeted curriculum, and the delivery of a summer institute for teachers on game-based learning environments.

S6A.12.2 Interactive Whiteboard use in Two High-tech Science Classrooms: Technology Adoption and Integration

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Brian Drayton, TERC

Joni Falk, TERC

ABSTRACT: Interactive whiteboards (IWBs), first introduced in office settings, are becoming a fixture in classrooms from elementary school through college in many countries throughout the world. Previous research sets high expectations on IWB use in terms of increased student motivation and engagement, though these benefits are dependent upon teacher adoption and integration of the technology. The current study followed two high school science teachers over three years as they integrated, to varying degrees, the IWB into their regular classroom activities. The teachers represent two “types” of approaches to new technology, which we refer to as the “early adopter” and the “cautious user.” The “early adopter” actively explored the functionalities of the IWB and integrated it with other technology, so that the tool provided both support and amplification for key aspects of his practice. For the “cautious user,” the IWB’s usefulness grew slowly over time, from a tool to present lecture materials to a fully integrated way to encourage student interaction. We explore these teachers’ practice through various lenses and discuss the lessons learned for high school science teachers.

S6A.12.3 Making and Moving Ideas: Students Using XO Laptops to Create, Discover, and Share Ideas

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Danielle B. Harlow, University of California, Santa Barbara

Alyssa Krier

ABSTRACT: When considering technical literacy, many educators focus on students’ ability to use computers. However, children in primary schools today will need not only the skills to use technology, but the ability to create with technology. Through a year-long qualitative study of 20 third grade students, we investigated how children used XO laptops to collaboratively develop ideas and skills related to creating with technology. Children used the laptops to

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create through both intentional acts (which we call creative accomplishments) and unintentional discoveries (which we call creative discoveries). In the classroom, the students shared their creative accomplishments and discoveries in different ways than they shared technical skills. These creative ideas, when valuable to the children became memes which moved throughout the classroom in unique ways. We leveraged this difference in idea sharing and propagation to understand what counted as memes to the children, in what contexts, and under what conditions as well as how these changed over time. Understanding how children take up and use different types of ideas as they interact with new technology has implications for the types of opportunities for learning with technology we provide children.

S6A.12.4 Study the Effectiveness of Interactive Whiteboard in Facilitating Junior High School Students' Biology Learning

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Tzu-Hua Wang, National HsinChu University of Education

Mei-Hung Chiu, National Taiwan Normal University

ABSTRACT: Interactive Whiteboard (IWB) revolutionizes not only the traditional classroom teaching environment but also the history of the whiteboard. This research tries to investigate the effectiveness of IWB in facilitating students' Biology learning in a traditional learning environment. Quasi-experimental design was adopted. 54 seventh graders of junior high school participated in this research. All students were divided into two groups, IWB group and T group. Students in IWB group learn in the environment implemented with IWB integration into teaching. However, Students in T group learn in the environment implemented with traditional information technology integration into teaching. The result indicates that students in IWB group have significantly better learning effectiveness than those in T group.

Strand 13: History, Philosophy, and Sociology of Science

S6A.13 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.13.1 Young Children's Images of a Scientist: Revisiting the Draw-A-Scientist Test

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ABSTRACT: Researchers have suggested that there is a relationship between students' images of scientists, their perceptions of themselves as scientists, and their attitudes towards selecting science-related careers (Boylan et al., 1992; Buldu, 2006; Kahle, 1988; Mead & Métraux, 1957). Previous research indicates that young people's images of scientists, particularly girls', are often incongruent with their own identities, leading them to "reject identities" related to science (Osborne, Simon, & Tytler, 2009). Additionally, it has been argued that once students have developed their images of scientists, these images may be "more stable than the facts and laws students learn in their school lessons" (Sjøberg & Imsen, 1988, p. 238). This paper explores the images of scientists held by early elementary school students, particularly beginning kindergarten students who have had little exposure to formal science instruction in schools. Findings reveal promising changes in young children's perceptions of scientists compared to previous DAST data, most notably in terms of gender representations of scientists and scientific activities. These data speak to the range of young students' scientific knowledge and experiences, and suggest that further research should be conducted to understand children's early experiences with science and how these shape their developing conceptions of science and scientists.

S6A.13.2 The Superconductivity Centennial: A Very 'Cool' Subject for Teaching the Nature of Science

Mehmet F. Tasar, Gazi Universitesi, mftasar@gmail.com

ABSTRACT: The year 2011 will mark the 100th anniversary of the discovery of superconductivity. In this paper I will discuss several features of this fascinating physical phenomenon in chronological order from the point of view of explicating how science is conducted. The purpose is to clarify the role and importance of theories, their relationship to scientific laws and discoveries of scientific facts. Moreover, superconductivity research is closely related to developing technologies such as transportation, electricity transmission, building more efficient engines, and energy storage. Hence, by beginning the original discovery and throughout its history, superconductivity is closely linked to technology. In this

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way, the relationship between science and technology can be revealed. By examining the historical records, memoirs, seminal scientific papers, and the discussions surrounding superconductivity it will be shown in this paper that the short history of superconductivity, without going into the details of the physics involved, can vividly exemplify the actual making of science when interwoven with the ideas of philosophy of science.

Strand 14: Environmental Education

S6A.14 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.14.1 Environmental Education in Pre-Service Teacher Preparation

Scott A. Ashmann, University of Wisconsin-Green Bay, ashmanns@uwgb.edu

ABSTRACT: If teachers are not adequately prepared to teach their K-12 students about the environment, then our hope of the next generation being able to help solve environmental problems has taken a serious blow. The goal of this study was to review the preparation of teacher candidates with respect to environmental education. Data were gathered from each of the 32 teacher education programs within a Midwestern state, including syllabi, major assignments, descriptions of environmental education

preparation, and an indication of which of the teaching standards were being met. Data from the surveys were augmented with data from interviews with representatives from an array of these programs. The findings show a wide variety of ways in which teacher preparation includes environmental education, such as requiring the completion of science content courses, integrating environmental education topics into science methods courses, and participation in environmental education training, like Project WET, Project WILD, and/or Project Learning Tree. Noted trends in the data included a weak connection between environmental education and social studies and a lack of follow-up to determine the extent to which pre-service teachers teach environmental education in their student teaching experiences.

S6A.14.2 Middle School Students' Decisions about Global Endangered Species Management Dilemmas

Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu

Lynn Gilbert, Conrad Ball Middle School

Pam Breitbarth, Conrad Ball Middle School

Alison M. Wallace, Minnesota State University Moorhead

ABSTRACT: Writing can be an effective way to guide students to think about global ecological issues from multiple perspectives. However, students are not always able to weigh tradeoffs between different solutions to socio-economic dilemmas. During a 4-week long Ecology unit, two 7th grade teachers (one English and one science) teamed up with two researchers to integrate writing-to-learn activities into their curriculum (with other inquiry activities). Students (n=68) chose a specific endangered vertebrate to study and write about, during which time they visited a large urban zoo that has an active conservation education program. Students wrote about the dilemmas involved in managing endangered species in other countries. We found that 41% of the students were able to identify ecological dilemmas in managing animals and 51% were only able to explain the issues (without describing trade-offs). In addition, some students were unable to make local connections (i.e., how their actions affected local species), and others did not recognize that humans compete for limiting resources with non-human animals and instead believed that humans are selfish and uncaring. These findings suggest that middle school students need more explicit scaffolding when considering global perspectives.

S6A.14.3 Exploring the World: Comparing Student Learning in Environmental and Science Inquiry Programs

Oksana Bartosh, Directions Evidence and Policy Research Group, ksenia_brt@yahoo.com

Jolie Mayer-Smith, University of British Columbia

Margaret Tudor, Pacific Education Institute

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Linda Peterat, University of British Columbia

ABSTRACT: This paper describes a study of two high school programs taking place in one school. One program uses environment as an integrating context for teaching science. The other program adopts an inquiry approach. We use quantitative and qualitative measures to compare these programs to determine the impact of this EE-based program on students' understanding of science and inquiry. The findings indicate that students involved in the environmental program develop better inquiry skills and gain understanding of science and environmental concepts. We argue that this environment-based approach allows us to educate citizens of the future who would have knowledge and skills to address the environmental problems the world is facing. This study aims to inspire educators to imagine the potential of adopting integrated environmental programs to enhance learning, empowerment, and environmental consciousness.

S6A.14.4 Combining Environmental Education and Integrated STEM Instruction: A Model and Case Study

Daniel L. Dickerson, Old Dominion University, ddickers@odu.edu

Patti Horne, Averett University

Stephanie Hathcock, Old Dominion University

Eileen Hofmann, Old Dominion University

Laura Nelson, Portsmouth Public Schools

ABSTRACT: This study examined the efficacy of a model that combines environmental education and integrated STEM instruction as measured by elementary students' attitudes and understandings. We employed an embedded, single case study design that drew on data sources including student responses on the Summer Academy Evaluations (Likert and open-ended), researcher-developed pre/posttest items, pre/posttest Draw An Environmental Scientist and Draw an Environmental Caretaker instruments, pre/posttest state standardized test items, and Summer Academy artifacts (e.g. drawings of students' buoy designs, students' constructed buoys, etc). The context of the study is Project SEARCH, a two-year NOAA-funded project, aimed at enhancing students' understandings and attitudes regarding the Chesapeake Bay. Findings included students indicating that they most valued the engineering/design activities, evidence of increased science content knowledge, increased awareness of STEM-related fields, and enhanced attitudes towards and understandings of the environment. Implications are discussed for curricula design in which the goals of environmental education and STEM education are present.

S6A.14.5 Indicators for Environmental Literacy: Local vs. Global Knowledge

Tali Tal, Technion, rtal@technion.ac.il

Einat Peled, Technion

ABSTRACT: The development of an environmental literacy instrument that addresses local and global knowledge as well as systematic and action related knowledge was at the center of this study, carried out in Israel. In developing the instrument, we adopted the "mutualism idea" suggested by Gough who questioned the relationships between science and environmental education. We describe the development of the instrument and its constituents. We administered the survey to 6th, 9th and 11th graders and found that the students' systematic global knowledge was better than their local and action related knowledge. The differences between the grade levels were significant. In the awareness-sensitivity and the behavior sections we found higher pre-environmental views among the younger students. We argue that the national curriculum covers mainly general systematic knowledge, and that the agencies and organizations that provide environmental education programs to the schools should be concerned about the limited local and action related knowledge of the students that can predict personal engagement better than the general knowledge.

S6A.14.6 Ecological Sustainability and Place-based Learning: A Model of Education for Transformative Experiences

Julie Singleton, Texas A&M, jsingle47@yahoo.com

ABSTRACT: Education for sustainability must necessarily be transformative from global, societal and personal perspectives. This conceptual paper seeks to present a unifying framework for ecological sustainable learning within the context of place-based education and the construct of transformative experience. Place-based education and education for ecological sustainability are multi-disciplinary areas that cover many areas of study. To begin discussion of ways to synthesize this broad field, the model addresses three learning domains and includes the transformative learning theory

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concepts of reflection, relational knowing and deep engagement as related to the authentic, meaningful context of place. The model contains the measurable constructs of expanded perception, expanded value and proactive use of environmental concepts. Further work on this paper will explore aspects of transformative experience, reflection, relational knowing and deep engagement in support and extension of this theoretic framework.

Strand 15: Policy

S6A.15 Poster Session A

3:15pm – 4:15pm, Grand Sierra D

S6A.15.1 Ohio Biology Teacher Licensure Requirements: Implications for Evolution Instruction

Lisa A. Donnelly, Kent State University, ldonnell@kent.edu

Vanessa Klein, Kent State University

ABSTRACT: Evolution is the central organizing principle of biology, but it is sometimes de-emphasized in high school biology classes. Completion of a college-level evolution course may be related to evolution teaching practices. Given the disparity between the centrality of evolution to biology as a discipline and teachers' sometimes minimal treatment within high school biology classrooms, we sought to examine the prominence of evolution in biology teacher education. Data for 30 of the 46 biology licensure-granting institutions (10 public, 20 private) within the state were examined with respect to their content course requirements. Data analysis consisted of descriptive statistics about the relative percentages of courses offered and the total number of biology credits required for these biology teacher licensure programs. Additionally, inferential statistics were employed to compare multiple/single licensure programs and private/public institutions with respect to their biology licensure requirements. Two main findings emerged. First, across the 85 biology licensure programs examined, evolution was required less frequently than other common biology sub-disciplines. A second finding was the wide variability in biology credits required for biology teacher licensure. Single licensure programs on average required significantly more biology credit hours than did multiple licensure programs. Implications for science educators designing programs are discussed.

Strand 1: Science Learning, Understanding and Conceptual Change

S6B.1 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.1.1 Electric Current Mental Models of Japanese and U.S. students

David Henry, Buffalo State College, henryd@buffalostate.edu

Michael Jabot, SUNY Fredonia

Koichi Furuya, Hokkaido University of Education

ABSTRACT: The Electric Current Assessment (ECA) was used to assess mental models of students when they explain what is happening to electric current in simple battery and light bulb circuits, including arrangements with short circuits. Approximately 120 Japanese grade 8 students, 50 U.S. grade 9 students, and 200 U.S. Grade 11 and 12 students participated in the study. All students had instruction in electric circuits, including electric current, voltage, resistance, and Ohm's law. The ECA identifies three mental models used when analyzing how much electric current is drawn from a battery and three mental models used when analyzing how electric current flows through a circuit. Our findings show that all populations used the scientifically-accepted mental model less than 20 % of the time. Instruction in electric current and circuits had little effect on the mental models the students used.

S6B.1.2 Facilitating Synthesis Problem Solving with Conceptual Scaffolding in Introductory Physics

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ABSTRACT: Problem solving is an important component in introductory physics education. A routine practice in that matter is to assign students a large number of traditional end-of-chapter exercises. However, such exercises often are

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localized, addressing topics only covered in single chapters. Students can easily complete these exercises by performing “plug-and-chug” using locally introduced formulas without a deep understanding. Frequently doing these tasks can eventually habituate students to the novice-like problem solving approaches. We used synthesis problems, which combine topics that are broadly separated in the teaching timeline, to militate against this phenomenon. Since synthesis problems are not familiar to students, we designed conceptual scaffolding to facilitate their attention to the underlying fundamentals. Specifically we encapsulated each synthesis problem with two preceding concept questions that share with it the same deep structure. After answering the concept questions and before solving the problem, students were explicitly reminded to search for the underlying connections. This paper investigates the effects of conceptual scaffolding in student solving synthesis problems through both qualitative and quantitative studies. Results on the effects of conceptual scaffolding in comparison with direct cueing (directly telling students what relevant concepts to use) are reported.

S6B.1.3 Association Between Belief and Conception of Evolution

Heeyoung Cha, Korea National University of Education, hycha@knue.ac.kr

Yangsuk Heo, Pohang Idong High School

Minsu Ha, The Ohio State University

Seulae Ku, Korea National University of Education

Hyemin Park, Korea National University of Education

Soon-nam Lee, Korea National University of Education

ABSTRACT: This study was conducted with participants who are Christians and non-Christians, as the goal of the study is to explore the relationship between their religious belief and their understanding of evolution based on constructivist’s perspective that understanding of evolution may be influenced by personal religious belief. Participants were consists of 60 teachers, 161 students, 52 priests, however, the teachers who majored biology-related subject and the student who have their personal religious faith were considered and classified from who were not. The test papers that were used in this study are ‘Evolution and Personal Religious Belief Attitude Survey’ and ‘Conception of Evolution’, however, ‘Conception of Evolution Survey’ was adjusted the number of selection in the question for the best suitability to the purpose of this study. The result this study most members of teachers especially the one who majored biology-related subject, believed in the fact that natural selection occurs after a mutation which is scientific conception of evolution. The group with high Christian belief choose teleology rather than the natural selection, in addition, the group with high evolutionary belief choose the fact that natural selection occurs after a mutation process.

S6B.1.4 Examining Student Writings of Argument-Based Inquiry Approach

Saeyeol Yoon, University of Iowa, saeyeol-yoon@uiowa.edu

Jeffrey Perkins, University of Iowa

Nattida Promyod, University of Iowa

Claudia P. A. Mendez, University of Iowa

Brian M. Hand, University of Iowa

ABSTRACT: The aims of this study are 1) to build up a matrix to evaluate students’ knowledge which is constructed in their writing, and 2) to investigate knowledge students have constructed in the writings throughout one academic year. Twelve fifth grade students in a school located in the mid-west of the U.S. participated in this pilot study throughout one academic year from fall 2008 to spring 2009. For the analysis of these data we use two matrixes; one for evaluating writing skills and the other to analyze the science knowledge. Our findings indicate the interrelationship between writing to learn approach and learning science through argument-based inquiry approach. Moreover, our findings highlight the importance of knowledge construction in learning science. In this regards, this study will contribute to science educators and science teachers by providing new matrix, helping develop their understanding of students’ knowledge construction. However, there are some needs to explore students knowledge construction through dialogical interactions as a process of argumentation as well as writings. Furthermore, we need to continually focus on the challenges facing teachers in shifting their orientation toward argumentation to learning and writing to learning in learning and teaching science.

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S6B.1.5 High School Students' Interpretations of Cellular Transport Graphics

Michelle Cook, Clemson University, mcook@clemson.edu

ABSTRACT: The purpose of this study was to examine how prior knowledge of cellular transport influenced how high school students viewed and interpreted graphic representations of this topic. The participants were Advanced Placement Biology students (n=65). After assessing prior knowledge using the Diffusion and Osmosis Diagnostic Test (Odom & Barrow, 1995), eight graphical representations of cellular transport processes were selected by the teacher and used during classroom instruction on this topic. Questionnaires were used to investigate differences in perceived salient features of the graphics, interpretations of the graphics, and processing difficulty experienced while interpreting the graphics. The results revealed differences in how high and low prior knowledge students interpreted the graphics. Without adequate domain knowledge, low prior knowledge students focused on the surface features of the graphics (ex. differences in particle color) to build an understanding of the concepts represented. On the other hand, with more abundant and better-organized domain knowledge, high prior knowledge students were more likely to attend to the thematically relevant content in the graphics and construct deeper understandings.

S6B.1.6 Interpreting Probabilistic Causal Outcomes in Science: A Microgenetic Study of Sixth Graders' Patterns of Reasoning

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Shane Tutwiler, Harvard Graduate School of Education

Leslie Duhaylongsod, Harvard Graduate School of Education

Molly Levitt, Harvard Graduate School of Education

Erika Spangler, Harvard Graduate School of Education

ABSTRACT: How students deal with probabilistic causality and interpret outcomes that do not have one to one correspondence with their effects is critical to how they learn science to how they figure out the world around them. Microgenetic studies were carried out over five sessions with four sixth graders to assess their assumptions when dealing with stochastic tasks. Sessions began with open-ended questions to reveal how students structured their expectations and explanations. Attempts to scaffold students' understanding were made reasoning analogically using tasks from four domains: social; games; machines; and biology. Sessions were intensively analyzed to identify whether and when shifts took place and what elicited them. The results are interpreted through the lens of Siegler's "Overlapping Waves Theory" (1996) along five dimensions: path, rate, breadth, source, and variability. The students all responded to the tasks with a deterministic stance, even in the case of biological and social tasks. There was some movement across the sessions towards a reflective stance on probabilistic causation. The results have implications for how students view patterns of evidence in science and whether it supports a given explanatory model as well as for how teachers discuss patterns of evidence in science.

S6B.1.7 Exploration of Using Narrative to Scaffold Levels of Representation in a Multimedia Simulation for Introductory High School Chemistry

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Jan Plass, New York University

Bruce Homer, City University of New York

Trace Jordan, New York University

Ruth Schwartz, New York University

Mubina Khan, New York University

Dixie Ching, New York University

Yoo Kyung Chang, New York University

ABSTRACT: Understanding levels of representation—observable, explanatory, and symbolic—is central to learning chemistry. The question of how we can design computer-based dynamic simulations to scaffold student understanding of these levels is the major

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question framing more focused questions addressed by usability and classroom studies presented here. Our findings indicate that narrative scaffolds may provide structure for introducing observable phenomena, offering common ground for discussion, generating motive (need to know) and so engaging students, facilitating content learning and transitions between different levels of representation. The challenge of motive is a major focus of the presented studies. However, findings also indicate that interactions between learning outcomes and process data such as time-on-task and click counts are more nuanced than initially anticipated, suggesting the need for further studies on narrative design and student use of narrative features.

S6B.1.8 Cross-cultural Comparison of SI-native and Imperial-native Students' Understanding of Size and Scale

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ABSTRACT: The concepts of size and scale are important for science learning. Scale is a “common theme” that pervades science, and that can be used to unify student learning (AAAS, 1993). Measurement units are important in conceptual understanding of size and scale, serving to off-load error-prone reasoning processes onto the notational system. US students may be at a disadvantage in their learning about size and scale through lack of familiarity with the predictable and systematic SI system of units. This would be analogous to the advantage of speakers of Chinese on early mathematical skills, partially due to greater transparency of the Chinese numbering system. This study tests how Imperial-native students perform compared to SI-native students, holding two known correlates fairly constant: SES, and degree of transparency of language in relation to the base-ten numbering system. This study includes matched comparison groups with SI- and Imperial-native students at the same US-accredited private school in Mexico City, and between SI-native students from that school and Imperial-native students in a comparable private school in the Midwestern US. A written test and individual interview were used. Preliminary results appear to trend in favor of SI-native students. Implications for curriculum and instruction are presented.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S6B.2 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.2.1 Investigating Students' Strengths and Weaknesses in the Area Scientific Inquiry

Manja Erb, erb@chemie.fu-berlin.de

Claus F. Bolte

ABSTRACT: Due to the established mandatory education standards in Germany and in the United States students have to meet high demands, also in the field of „scientific inquiry“, which includes the ability to plan scientific investigations and to carry them out self-reliantly. The results of the TIMSS and PISA investigations showed that students are not able to fulfill these requirements of the education standards. Inadequate views about nature of science (NOS) constitute a potential explanation. We assume that - to achieve an adequate view of NOS - reliable abilities in the area of scientific inquiry are indispensable. Therefore, we developed an instrument to analyze the students' strengths and weaknesses in the domain “scientific inquiry”. We restricted the questions to the partial competences “scientific observations” and “scientific assumptions” and presented our instrument to more than 650 students in grades 5 and 6. Furthermore, the initiation of our instrument discloses a possibility to compare self-assessment with actually obtained abilities or difficulties. The results contribute to what has to be considered in learning and teaching in the field of scientific inquiry.

S6B.2.2 Epistemology and Personality Traits as Predictors of Scientific Reasoning Ability

Gavin W. Fulmer, gavinfulmer@hotmail.com

ABSTRACT: Why do some students reason about scientific phenomena more effectively than do other students? Prior research shows reasoning is affected by one's knowledge and interest in the subject (e.g., Ericsson & Kintsch, 1995; Murphy & Alexander, 2002). Individuals' epistemological stances (e.g., Tytler & Peterson, 2003) or other personality characteristics may also affect their science reasoning. This study tested the effect on students' science reasoning of epistemological beliefs, attitudes, and perceptions of science after accounting for prior knowledge and interest. The

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findings indicate that students' reasoning abilities differed according to their need for predictability, belief in fixed-intelligence, and view of science as inclusive. The paper describes directions for future research on possible causal relationships among these variables and on pedagogy to help students improve their reasoning.

S6B.2.3 Towards Improving the Measurement of Quality of Argument Using Toulmin's Framework: A Methodological Contribution

Maria P. Evagorou, University of Nicosia, Cyprus, evagorou.m@unic.ac.cy

Jonathan F. Osborne, Stanford University

ABSTRACT: This paper is a methodological reflection on the analysis conducted using Toulmin's framework as a way to measure students' success when constructing written arguments. The purpose of this paper is to explore what counts as quality of argument in science education. The discussion is drawn from empirical evidence from the implementation of a learning environment for argumentation in two different high school classes, which made use of the Toulmin's (1958) framework to evaluate students' arguments in these two classes. From the analysis we identified the shortcomings of the Erduran et al. (2004) modified version of Toulmin's framework and the need for an additional criterion of 'quality' when using this framework – one which accounts for the number of pieces of evidence. Hence we propose the addition of an intermediate level. Using this modified framework we show how the analysis of the data from the two classes is a more valid measure of student "success" in argumentation. Adding the intermediate level the framework can also be used to evaluate both written and oral arguments.

S6B.2.4 Blending Physical and Virtual Manipulatives in Physics

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Zacharias C. Zacharia, University of Cyprus

ABSTRACT: This study aimed to investigate the effect of experimenting with Physical Manipulatives (PM), Virtual Manipulatives (VM), and a blended combination of PM and VM on undergraduate students' understanding of concepts in the domain of Light and Color. A pre-post comparison study design was used for the purposes of this study that involved 70 participants assigned to three conditions. The first condition consisted of 23 students that used PM, the second condition consisted of 23 students that used VM, and the third condition consisted of 24 students that used the blended combination of PM and VM. In the case of the blended combination, the use of VM or PM was selected based on whether it provides an advantage/affordance that the other medium of experimentation (PM or VM) cannot provide. All conditions used the same inquiry-oriented curriculum materials and procedures. Conceptual tests were administered to assess students' understanding before, during, and after teaching. Results revealed that the use of a blended combination of PM and VM enhanced students' conceptual understanding in the domain of Light and Color more than the use of PM or VM alone.

S6B.2.5 Teacher's Views on Science, Teaching Science, and Their relationship to Argumentation Norms in a Classroom

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ABSTRACT: The present study examines how a teacher's beliefs about science and teaching science are related to the building of argumentation norms and possibly the epistemic understanding of students in a combined third- and fourth-grade science classroom. To investigate a teacher's views about science and teaching science, several interviews and two NOS instruments were conducted and analyzed. To examine the interplay between teachers' views and the impact of the building of classroom norms, I compare and contrast interview, NOS instrument, and classroom video data results, collected during the entire school year (2009-10). The finding suggests the close relationship between teachers' understanding of science, views on teaching science, and development of argumentation norms in the classroom. This teacher's understanding of argument as a critical activity in science led her to set up a clear goal; namely, for her students to convince each other like scientists in the classroom. This, in turn, encouraged students to generate and refine their argumentation norms such as back up your claims, show your evidence and provide justification. Her emphasis on empirical data and evidence and on equal participation and intellectual status of scientists seemed to be reflected as norms in the classroom.

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S6B.2.6 Young Children Do Not Hold the Classic Earth's Shadow Misconception to Explain Lunar Phases

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ABSTRACT: A case study of four young children was conducted to shed light on the process that children undergo in developing their understanding of physical phenomena. Using the notion of spontaneous construction and its relationship with school learning of scientific concepts, children's early thoughts regarding the moon's appearance were explored. No shadow misconceptions as a cause of lunar phases were observed. The external interest of this research study involves when and why do children develop the commonly held Earth's shadow misconception as the cause of the moon's phases. Two Piagetian interviews were conducted, the first involved a lunar protocol and the second (given a week later) was a shadow protocol. By better understanding how children think about the moon's changing appearance and knowing that young children do not tend to hold the shadow misconception, one can see what children bring to the classroom environment where their "school learning" begins. The capable teacher must know the student and create a learning environment that incorporates experiences for students to move through their understanding with appropriate models and innovative resources taking care to facilitate understanding and not create new misconceptions such as that of the classic shadow misconception.

S6B.2.7 Nature of Science Communication in Teacher Personal Pronouns

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ABSTRACT: This study explores how personal pronouns used by elementary teachers during science inquiry discussions communicate or frame teacher-student-science relations. Teacher pronouns are viewed as symbolically expressing cognitive meanings (scientific thinking, forms of expression and concepts) and indexically communicating social meanings (hidden messages about social and personal aspects of science – human agency, science membership, and gender). Through a semiotic analysis and construction of interactional maps, I examine participant examples (oral descriptions of actual or hypothetical situations wherein the teacher presents herself and/or students as characters to illustrate topics under discussion. Teacher use of the generalized you communicated to students how to mean scientifically while I communicated scientific ways of thinking and reasoning. Furthermore, teacher pronouns communicated the social nature of science as well as multiple frames that were inclusive of some students (mainly boys) but that excluded girls (i.e. positioned them as science outsiders). Exclusive use of he is taken as indicative of a gender bias. It is argued that teachers should become more aware of the range of personal pronouns available for science instruction, their affordances and constraints, their potential as tools for humanizing and personalizing impersonal science curricula as well as the risk of 'nature of science' miscommunication.

S6B.2.8 Investigating Discursive Practices Utilized Students and their Teacher in a Freshman-Level High School Science Course

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ABSTRACT: This study sought to identify the ways in which one science teacher intended to promote science discourse among her students, many of whom were English language learners, and describe the discursive practices visible during classroom activities. The context of this study was a freshmen-level high school introductory science survey course that encompassed select topics from earth science, physics, chemistry, and biology. Participants included ten students (half of whom were designated as English language learners by the district) and their teacher. A lesson sequence on sound waves lasting five class periods of eighty minutes each was filmed. Additional data collected included two interviews with the teacher, teacher lesson plans, and two student focus group interviews. Presented findings highlight the aspects of science discourse that students found difficult even in a classroom where the teacher explicitly considered such discourse as a learning goal. This work extends the research base on science discourse, particularly with respect to the discursive practices of English learners at the high school level.

S6B.2.9 Examining How Elementary Students Generate Inferences When Reading Informational Science Texts and Interpreting Scientific Data

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ABSTRACT: This research examined how elementary students engage in the process of inference generation when reading informational science texts and interpreting scientific data. A sample of 84 third grade students reading on or above grade level read informational texts focused on explaining how sound is made and how plants grow and interpreted scientific data on the same topics. The study used think-aloud protocol methodology to capture the students' thinking during reading. The nature and extent of students' inferential reasoning was analyzed for: 1) frequency and types of inferences generated across text types and topics and 2) relationship with prior knowledge and comprehension. Results provide empirical evidence to show the importance of prior knowledge and explanations in building students' conceptual understanding.

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

S6B.3 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.3.1 Making the Invisible Visible: Exploring Science Literacy through Creation of Non-fiction Science Picture Books

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Jan Buley, Laurentian University

ABSTRACT: One challenge confronting science education preparation is the fact that K-8 elementary pre-service teachers come to science methods courses with uneven science content knowledge. The problems of teaching science are more pronounced in Middle School where some teachers resort to having students read from a dense textbook. In order to be able to teach science for understanding, beginning teachers need to have a balanced understanding of content and general pedagogy. The purpose of this integrated science and literacy study was to investigate the impact of creating non-fiction science picture books on elementary pre-service teachers' development of science literacy skills as well as development of their pedagogical content knowledge. Data for the study were collected through analysis of the picture books created by the pre-service teachers and interviews. A science and Literacy Framework (Zales & Unger, 2008) was used to analyze the picture books as well as the interviews. Findings from the study showed that the process of creating and sharing non-fiction science picture books with school age children improved the pre-service teachers' understanding and presentation of science content, and the process also had a positive impact on their confidence and self efficacy in science teaching.

S6B.3.2 Exploring Primary Teachers' Epistemological Understandings and Dilemmas of School Science Lab Practices

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Myeong-Kyeong Shin, Gyeongin National University of Education

Gyuho Lee, Seoul National University

ABSTRACT: The purpose of this study was to explore primary teachers' epistemological understandings and dilemmas of science and science teaching and learning, especially focusing on school science laboratory. Five primary science teachers were participated in this study. They had a black-box activity and group discussions on various topics of science, school science, science laboratory, science teaching and learning in the venue of four seminars. Their activity and discussions were videotaped and transcribed. Several epistemological issues were emerged in their activity and discussions. Results involved four epistemological understandings and two dilemmas of the teachers. Based on the results, discussion and implications about science education and science teacher education were presented.

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

S6B.4 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

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S6B.4.1 The Relationship between Nature of Science Understandings and Science Self-efficacy Beliefs of Sixth Grade Students

Beth Allyn Parker, Georgia State University, eap1961@comcast.net

Geeta Verma, University of Colorado Denver

Lisa Martin-Hansen, Georgia State University

Ray Hart, Georgia State University

ABSTRACT: The hypothesis put forth by researchers is that students need to observe models of how science is done, the nature of science (NOS), so that they connect with the human enterprise of science and thereby raise their self-efficacy (Britner, 2008). This study examined NOS understandings and science self-efficacy of students enrolled in a sixth grade earth science class taught with explicit NOS instruction. A mixed method design was employed following an embedded experimental model (Creswell & Plano Clark, 2007). As the treatment, five NOS aspects were first taught by the teachers using nonintegrated activities followed by integrated instructional approach (Khishfe, 2008). Students' views of NOS using the Views on Nature of Science (VNOS) (Lederman, Abd-El-Khalick, & Schwartz, 2002) along with their self-efficacy beliefs using three Likert-type science self-efficacy scales (Britner, 2002) were gathered. Composites of participants' responses to the two instruments, the VNOS-E and Science Self-Efficacy Scale, were scored and analyzed using a Chi-square and MANCOVA, respectively with pretest scores as covariates. Findings indicated that explicit NOS instruction was effective for all students except minority (Black, Hispanic, Asian, or multiracial) male students in improving NOS understandings. Furthermore, all students that received NOS instruction demonstrated decreased anxiety towards science.

S6B.4.2 Fostering Transfer of Learning in 9th Grade Chemistry Lessons using the Scientific Method as an Example

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Rüdiger D. Tiemann, Humboldt-Universität zu Berlin, Germany

ABSTRACT: The scientific method is as an example for a series of problem solving steps that could be taught for transfer in science lessons. In this study teaching and learning material is designed according to transfer-facilitating factors (Barnett & Ceci 2002). It is assessed how pupils transfer the taught problem solving steps to new problems. First results will be discussed.

S6B.4.3 A Critical Analysis of Force and Motion Unit at a Newly Reformed Science and Technology Curriculum

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Bugrahan Yalvac, Texas A&M University

ABSTRACT: In this paper, we present a critical analysis of "Force and Motion" unit activities offered at the 7th level in a newly reformed Science and Technology Curriculum in Turkey. Our analyses were informed by Chinn and Malhotra's theoretical framework (2002) and Edelson's ideas about authentic science practices (1998). We do not criticize the new science and technology curriculum, indeed, we find it quite innovative and thorough, yet our analysis brought up a new discussion topic, that is, to what extent the student activities are authentic and effective in helping students portray an accurate representation of scientific practice. After noting the weaknesses of the newly designed curriculum unit, we propose using an immersion unit responding to the missing characteristics of the curriculum. Our proposed immersion unit was developed around the notions of authentic scientific practices and the even distribution of the power of ability to know between the students and the teacher.

S6B.4.4 Developing the TPACK of Secondary Science Teachers using the Interactive Whiteboard and Peer Coaching

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ABSTRACT: Many studies related to the use of interactive whiteboards (IWBs) in educational settings have shown that IWB technology can result in enhanced presentations and in the development of student motivation and student performance. However, the relationship between the use of IWBs and Technological Pedagogical Content and Knowledge (TPACK) by teachers is yet to be fully investigated and understood. The purpose of this study was to integrate IWB technology and peer coaching to develop the TPACK of secondary science teachers in real classrooms. An IWB-based peer coaching model was developed. Participants of this study included four in-service science teachers. The

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sources of data included written assignments, reflective journals and interviews. The results displayed three major findings. First, science teachers used IWBs as instructional tools to share their subject matter knowledge and to express students' understanding. Second, the IWBs helped the science teachers who encountered teaching difficulties in the traditional classroom better implement their representational repertoires and instructional strategies. Finally, the proposed model of integrating IWBs and peer coaching can develop the TPACK of science teachers. The research implications of this study are provided along with suggestions.

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

S6B.5 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.5.1 How Do Students' Approaches to Learning Science Relate to Their Ability to Ask Good Questions?

Erika G. Offerdahl, North Dakota State University, erika.offerdahl@ndsu.edu

Lisa M. Montplaisir, North Dakota State University

ABSTRACT: The purpose of this study was to explore the nature of student questioning in undergraduate science. In particular, the goal was to better understand the influence of two variables – students' approaches to learning and stage in academic career – on the level of questions posed by students in two undergraduate science courses for majors. Students' questions were collected throughout the semester in an introductory and an upper-level science course in the form of reading questions. Reading questions are student-generated questions submitted electronically to an instructor prior to class about the assigned reading from the course textbook. Students' approaches to learning were measured using the Study Process Questionnaire (SPQ) published by Biggs (1987). Descriptive and inferential statistics were performed to gain understanding about the relationships between approaches to learning, stage in academic career, and level of questions. The findings from this study contribute to the sparse literature base on student questions in undergraduate science. Furthermore, they will be useful for university faculty, particularly those engaged in teaching science courses, as they endeavor to broaden students' understanding of the nature of science.

S6B.5.2 Teaching Quantum Physics: Impact on Learning Using a Representational Approach

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Promovendus Abdurrahman, Indonesia University of Education

ABSTRACT: The purpose of this study is to investigate the role of multiple representations-based instructions for pre-service physics students toward the students' quantum physics mastery achievement, generic science skills, and critical thinking disposition. The mixed method study was conducted on pre-service physics students at a public University in Indonesia. For assessing students' quantum physics performance and beyond, two instruments have been developed. The results revealed that multiple representations based-instructions had a significant effect toward pre-service physics students' quantum physics concept achievement compared to the conventional instruction. There were significant differences on students' critical thinking disposition in open mindedness, analyticity, systematicity, self confidence, and maturity of judgment.

S6B.5.3 A Longitudinal Perspective of Gender Differences in STEM Undergraduate Research Experiences

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Adam V. Maltese, Indiana University, Science Education

Robert H. Tai, University of Virginia, The Curry School of Education

ABSTRACT: The loss of talented women from the science, technology, engineering and mathematics (STEM) pipeline has been widely recognized within science education as a dominant issue, particularly in the physical sciences. As an effort to provide a

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gender-based perspective of a popular educational device, the present study evaluated undergraduate research experiences (UREs) in respect to learning enhancements and contributions to the pursuit of a post-graduate education. Data used in the analysis was collected in a national, mixed-methodology study designed to assess the transition of science graduate students into the fields of chemistry and physics. Survey responses from practicing scientists and graduate students, who had participated in UREs (n=1,829), indicated similar patterns in the greatest conferred gains for men and women. However, gender-based variations were observable within ratings for items associated with self-efficacy, science interest, and the practice of authentic research. Women were found to identify UREs as a primary reason for entering graduate school at a significantly higher rate than their male counterparts. Results of this study suggests the long-term efficacy of UREs as a gateway for women interested in STEM careers and provides support in the justification of research programs and initiatives for women in traditionally male dominated fields.

S6B.5.4 Boring, Cool, Enjoyable, Dull: Students' Interest during Analytical Chemistry Laboratory Activities

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Linnea Garrett, Illinois Institute of Technology

ABSTRACT: This qualitative study explores whether undergraduate students' interest can be aroused in a mandatory analytical chemistry class that generally is considered of little to no interest. Assuming that certain features of a learning situation arouse a person's interest regardless of personal preferences (interestingness or non-interest) for the situation this study asks: (1) Do a series of analytical chemistry laboratory activities, which are part of a required undergraduate analytic chemistry course, arouse students' situational interest? (2) If so, what stimuli promote situational interest and how does it develop throughout the semester? Results show that students' situational interest can be triggered through specific laboratory activities (modern instrumental techniques) as well as maintained throughout a lab by particular actions (e.g., instrumental measures) and personal relevance of analysis. Although this study's participants (n=8) did not maintain their situational interest over a longer period of time, our results suggest a re-design of the traditional laboratory format (less emphasis on wet labs, more emphasis on instrumental techniques) is likely to maintain students' situational interest, which then may develop into an individual interest in analytical chemistry, while at the same time, allow students to acquire theoretical knowledge and professional competencies in state-of-the-art analytical chemistry techniques.

S6B.5.5 A Phenomenological Study of Non-science majors' Perceptions of Evolution

Emily M. Walter, University of Missouri, emw2n4@mail.mizzou.edu

Patricia M. Friedrichsen, University of Missouri

ABSTRACT: Evolution is an important underlying theme of biology and a critical component of scientific literacy. Most research surrounding evolution education seeks to quantitatively uncover relationships between facets of knowledge and acceptance of the theory as valid. This study uses qualitative phenomenological methods to investigate the lived experience of evolution of 4 non-science major undergraduate students. Similar meanings behind evolution experiences were found among the participants: they believed evolution to be primarily a theory about human origins, had developed a level of acceptance of the theory, acknowledged awareness of their own fragmented content knowledge, and in some cases, had epistemological discomfort with the tentative aspect of the nature of science. Most of these meanings developed from classroom experiences in middle and high school. These classroom experiences were different between participants that attended public school and the participant that attended Catholic high school, resulting in different perspectives at the college level. Results are compared to studies of perception of evolution in other populations and implications for instructors and researchers are given.

S6B.5.6 Students' Perceptions about Their Learning Experience through a Process-oriented Chemistry Laboratory Curriculum

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Beverly Pestel, Indiana State University

ABSTRACT: This study explored university students' perceptions about their learning experiences with a new process-oriented chemistry laboratory curriculum. Specifically, this study investigated the knowledge of chemistry processes

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(i.e., how chemical knowledge and products are acquired) university students perceived that they developed through the process-oriented curriculum. This study also explored how the students perceived that their attitudes toward chemistry learning changed throughout the course. The context of this study was a 1-credit introductory chemistry laboratory course that was taught with the newly developed process-oriented laboratory curriculum. The data regarding the students' perceptions about their learning experience were collected through SALG (Student Assessment of their Learning Gains). The SALG is a free web-based course-evaluation tool that allows college-level instructors to gather learning-focused feedback from students. The students perceived that they learned the main concepts of the course to a great degree and developed various science process skills such as teamwork, communication, and observing and organizing data. The students also perceived that their interest, motivation, and confidence in chemistry learning increased. The results of this study suggest that a process-oriented laboratory curriculum contributed to improving university students' understanding of chemistry processes, science process skills, and positive attitudes toward chemistry learning.

Strand 6: Science Learning in Informal Contexts**S6B.6 Poster Session B**

4:15pm – 5:15pm, Grand Sierra D

S6B.6.1 Content Related Social Interactions during Professional Development at an Informal Science Institution

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Judith S. Lederman, Illinois Institute of Technology

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Currently, it is not clear whether professional development staffs at Informal Science Institutions (ISIs) are considering the way exhibits contribute to the social aspects of learning as described by the Contextual Model of Learning (Falk & Dierking, 1992, 2000). In order to move beyond only preparing science teachers for field trips, while necessary, it is also important to understand the role exhibits play in influencing teachers' content related social interactions while engaged in ISI professional development. This study looked at two life science courses that were offered at and taught by education staff of a large science and technology museum located in the Midwest. Elementary and middle school teachers that primarily taught science (n = 50) were audio and videotaped while participating in the courses and when interacting with the museum's exhibits. When considering the two factors within the sociocultural context of CML: within-group sociocultural mediation and facilitated mediation by others, the use of exhibits during both courses generally did not fully take into account these elements. However, when PD staff made explicit connections between exhibits, content, and activities, participants were more likely to be involved in in-depth, content related and pedagogical conversations while engaged in the course.

S6B.6.2 An Examination of Visitor Responses and their Meaning Making of the Von Hagens' Body Worlds Exhibition

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Michelle Dubek, OISE/University of Toronto

Erminia G. Pedretti, OISE/University of Toronto

ABSTRACT: Von Hagen's Body Worlds is a travelling exhibit that allows the public to experience the internal human body through the use of plastinated cadavers. Given the unique nature of the Body Worlds exhibit and its educational potential, this study will investigate how visitors make meaning of the Body Worlds exhibit. Specifically we examine the general responses of visitors to the exhibit, as well as the contexts of visitor meaning making viewed through personal, sociocultural, and physical lenses. Here we used Falk and Dierking's (2000) Contextual Model of Learning as a framework to organize visitor responses. Using a naturalistic qualitative case study approach, themes emerged from complimentary data sources—51 visitor interviews, 10 comment books (with approximately 2400 commentary each), field notes, and documentary material. Our study suggests that the personal context of learning in informal settings is central to visitor meaning making. In particular, personal histories and strong emotional responses were pervasive. Similarly the physical experience of the exhibit seemed to have a considerable impact on visitor responses. While most Body Worlds-related

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research is communicated through sociological, bioethical, or medical journals, this study considers visitor responses from a science education perspective.

S6B.6.3 Difficult Biological Concepts in Media Coverage

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Rundgren Shu-Nu Chang, Linköping University, Sweden

Chun-Yen Chang, National Taiwan Normal University, Taiwan

Yuen-Hsien Tseng, National Taiwan Normal University, Taiwan

ABSTRACT: The ability of citizens to be able to understand and critically read and discuss the scientific reports presented in media is of increasing importance in science education. The SLiM (Scientific Literacy in Media) approach, on which this study is based, gives a possibility to measure scientific literacy based on the most commonly appearing scientific terms in news media. This study analyzed the 22 biology items from the prior SLiM study and identified the most difficult biology concepts for Taiwanese (N=619) and Swedish (N=117) non-science majors from university and upper secondary levels. The correct rate (%) of each item was analyzed to present students' performances on each item. From the results, in general, it was found that Taiwanese students performed better than Swedish students at both university and upper secondary levels. However, Swedish university students were a bit better than the Taiwanese in definition-based (DB) items. Looking at the individual country, both Swedish and Taiwanese students' performances on context-based (CB) items were better than DB items with significant difference ($p < .01$). Among the four items that were found difficult for both Swedish and Taiwanese students, two relates to biotechnology, and the other two are about function of enzymes and cell biology.

S6B.6.4 Interactive Museum Workshop in Cell Biology Positively Impacts Nurses' Knowledge of Molecular Medicine

Kathleen M. Vandiver, Massachusetts Institute of Technology, kathymv@mit.edu

Catherine Ricciardi, Massachusetts Institute of Technology

Amanda N. Gruhl, Massachusetts Institute of Technology

Robin Meisner, MIT Museum

Jonathan M. Bijur, MIT Museum

Charles Shubert, Massachusetts Institute of Technology

Ivicta Ceraj, Massachusetts Institute of Technology

Lourdes Aleman, Massachusetts Institute of Technology

ABSTRACT: Modern medicine has become more molecular and genomic, as dysfunctional molecules inside of cells are now understood to be the root cause of disease. The authors tailored a popular teacher cell biology workshop with its hands-on participatory learning format to meet the needs of contemporary nursing practice. In teacher workshops, LEGO models of DNA and proteins are used to teach cellular processes, and 3D computer modeling programs are used to teach protein structure. Nurses reported that their prior formal cell biology training was either deficient or obsolete. A two-day workshop was offered January 2009 and 2010, with 38 participants being awarded continuing education credits (CEUs). To measure whether the instruction was effectively implemented, numerous metrics including of pre- and post-tests for content mastery, survey questionnaires, and long-term impact have been analyzed. The pre and post tests scores showed significant improvement in nurses' understanding of cellular processes with paired t test results of 1.52×10^{-9} . In satisfaction and in long-term impact (>six-months-after surveys), nurses also report that the workshop information was very empowering. Since nurses directly affect public health by teaching and counseling patients in their practice, this innovative and effective translational medicine workshop will continue to be offered annually.

S6B.6.5 Expanding the Depth of Informal Learning with Mixed Reality at Science Centers

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Eileen Smith, University of Central Florida

J. Michael Moshell, University of Central Florida

ABSTRACT: This paper describes two projects currently underway to explore the effectiveness of using Mixed Reality (MR) technologies to enhance learning and engagement at Science Centers. Specifically the projects attempt to achieve

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greater depths of learning by immersing the learner and giving them greater control over the scientific phenomena they are experiencing. The first project titled 'Dancing the Earth' is designed to facilitate body-based metaphors that put the learner inside a simulation for exploring concepts in physics. Using whole-body interaction with projected floor imagery learners can experiment with their assumptions about gravity, energy, etc. The second project titled 'Water's Journey' consists of several components that allow for 'scientific virtualization' or the process of interacting with visualizations of scientific data. In this exhibit visitors learn about the unique environmental history of Florida's Everglades through MR augmentation of physical artifacts. Measures of learning and engagement being applied to these exhibits and preliminary findings are discussed.

Strand 7: Pre-service Science Teacher Education

S6B.7 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.7.1 Evolution in Elementary Methods: A Practical Instrument Shows Attitudinal Change is Possible (but Tricky)

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

ABSTRACT: This study examines quantitative and qualitative data from an anonymous survey instrument designed to provoke affective reactions about Teaching Evolution in Public Elementary Schools (TEPES). The TEPES survey is easy to give and take, and can provide insight into student attitudes that help inform pedagogy and curriculum. This study used the TEPES as a pre (n=398) and posttest (n=351) in an elementary science methods course (14 sections over seven semesters). Although attitudes regarding evolution are notoriously difficult to change, the quantitative results indicated significant, desirable change on all five statements. Analysis of the qualitative data, which was often thoughtful and passionate, linked an understanding of why evolution should be taught to a greater understanding of aspects of the nature of science. The desirable change in attitudes may be the result of both a brief, explicit module on teaching evolution delivered as a socioscientific issue midway through the course, and the overall course tone, which emphasizes the importance of NOS and the value of science to children and society. Despite the positive results, the data indicate a need to change the effect size and reach more students, particularly on the matter of balancing evolution with creationism.

S6B.7.2 Analysis of Preservice Science Teachers' Understanding of NOS and Warrants on Socioscientific Issues

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Yasemin Ozdem, Gaziosmanpasa University, Tokat, Turkey

ABSTRACT: The purpose of current research is to explore the influence of a science teaching method course incorporating explicit reflective NOS instruction on preservice science teachers' views of NOS and warrants in their arguments related to their decision on socio scientific issues. This study is a case study conducted to explore the influence of a science teaching method course incorporating explicit reflective NOS instruction on preservice science teachers' views of NOS and warrants in their arguments on socio scientific issues. Participants of the study were 5 pre-service science teachers who are enrolled in elementary science teaching program. To track changes in participants' NOS views, The Views of Nature of Science Questionnaire was administered as pre- and post test. To examine students' source of warrants, the decision making questionnaire was administered as pre and post questionnaire. The research questions of the study were examined for each participant and presented to include the change in participants' NOS views, change in participants' source of warrants, and relation between participants' views of NOS and their warrants in their arguments on SSI. The results of the study showed that improved NOS views make shifts in the sources of warrants used to construct arguments on socio-scientific issues.

S6B.7.3 Impact of a Methods Course on Pre-Service Elementary Teachers with Negative Attitude and Low Self-Efficacy

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ABSTRACT: Reform initiatives stress the significance of early science experiences, but many elementary students continue to have poor or no science experience. Teachers' negative attitude, low self-efficacy with regard to science

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learning and teaching, and the misalignment of their beliefs with reforms may explain this trend. Changing instructional practices will require changes in these domains. Teacher belief has been studied extensively, but most studies are descriptive focusing on teachers' current beliefs. Few focus on pre-service teachers or factors responsible for possible changes. Many studies dealing with PSTs' self-efficacy and attitudes have been quantitative in nature, looking at changes in a population of students as part of a course or a program, rather than focusing on individuals. Finally, studies mainly focus one or two of the three constructs and do not consider the possible interrelationship between them. This qualitative case analysis study examined the impact of a science methods course on beliefs, attitude, and self-efficacy of two elementary PSTs' with initial low self efficacy and negative attitude toward science and science teaching. This group showed the greatest increase in attitude and self-efficacy and their beliefs about science, learning, and science teaching, underwent major changes. Factors responsible for these changes will also be discussed.

S6B.7.4 Prospective Elementary Teachers Enjoy Science: Orientations and Experiences that Influence their Development

Lucy Avraamidou, University of Nicosia, AVRAAMIDOU.L@UNIC.AC.CY

Maria P. Evagorou, University of Nicosia

ABSTRACT: A large body of literature illustrates that many elementary teachers are reluctant to teach science and confess a lack of confidence to teach it. Nevertheless, a review of the literature indicates a few cases of elementary teachers who do well in science and offers rare examples of enthusiast elementary teachers. The purpose of this study is to document three such cases of prospective elementary teachers (two of which are females), illustrate their unique characteristics and shed light on how those came to be. The study was designed upon a narrative inquiry approach focusing on the collection of personal stories, which builds on Dewey's philosophy of personal and social experience. Multiple sources of data were used in this study such as drawings, interviews, reflective assignments, and observations of their engagement in an elementary science methods course's activities. Analysis of the data illustrated that a variety of experiences the participants had during their coursework had a critical impact on their development: inquiry-based investigations, contemporary theoretical discussions, outdoors field study, friendly and fun classroom environment and the personality and characteristics of their instructors. These findings have implications for the design of science education courses that aim to engage prospective elementary teachers, and especially females, in meaningful learning experiences and support them in developing positive attitudes towards science.

S6B.7.5 Understanding Aspects of Pre-service Teacher Questioning Skills

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

Melissa L. Shirley, University of Louisville

ABSTRACT: Effective teacher use of pedagogical practices such as formative assessment has the potential to increase student understanding of science concepts. An important feature of formative assessment is teacher awareness of student understanding, which can be elicited using skillful whole-class questioning, including higher-order thinking questions, increasing wait-time and encouraging student participation in interactive discussions. How teachers develop expert questioning skills is not clear; consequently, this pilot study was designed to examine how pre-service teachers (PSTs) consider and then transform their questioning practices through self-analysis of transcribed excerpts of whole-class instruction. Preliminary findings show that most PSTs chose to categorize the cognitive level of questions they asked. Additionally, some PSTs focused on teacher-student interactions, such as provision of teacher feedback to students and the effect of student behavior on class discussion. PSTs identified tools, such as referring to lists of question prompts, as the main strategy for increasing the cognitive level of questions, which would improve class discussions. Overall, PSTs were surprised by their current questioning practices after analysis of their transcripts and readily dedicated themselves to strategies for improvement. This study should help teacher educators prepare novice science teachers more effectively and demonstrates a general method for understanding teacher skills development.

S6B.7.6 Preservice Teachers' Understanding and Implementation of Inquiry: Initial Findings from a Longitudinal Study

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ABSTRACT: The purpose of this study was to examine the effectiveness of embedding an inquiry approach in a secondary science methods course and the field experiences of preservice teachers. Data was collected from performances on tasks in the university course (teaching philosophy, teaching metaphor, inquiry investigations, and video-taped lesson reflections, surveys), observations of classroom implementation during an 8-week field experience and student-teaching experience, portfolio excerpts and interviews. Findings indicate that factors supporting implementation of inquiry include adoption of a constructivist educational philosophy, expansion of conceptions of inquiry through learning experiences in university science and education courses, as well as the sustained practice of teaching inquiry-based lessons in the field. While all key elements of inquiry were present in these novice teachers' lessons, the level of expectation in terms of student responsibility was rudimentary. Further research is needed to determine the factors that will better support preservice teachers' implementation of more open-inquiry lessons that encourage student responsibility in decision-making.

S6B.7.7 Preservice Elementary Teachers' Learning about the Five Essential Features of Classroom Inquiry

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Cory T. Forbes, University of Iowa

ABSTRACT: Preservice and beginning elementary teachers face many challenges in learning to teach science as inquiry. There is little research on preservice teachers' learning about inquiry-based science teaching within the 5 essential features of inquiry framework articulated by the National Research Council. In this study, we carried out case studies of 6 preservice elementary teachers enrolled in a science methods course to investigate their developing ideas about inquiry-oriented science. Data included interviews, course artifacts, and additional data around 2 lessons each preservice teacher planned and taught. The NRC's 5 essential features served as both a theoretical and analytical framework. Data were coded and cross-case analyses were conducted. Results indicate that the preservice teachers adopted the NRC framework to define inquiry, and adapted existing lessons around the framework. Students struggled, however, with separating the 3 features emphasizing explanations. We also found that preservice teachers' ideas changed over the semester about the purpose of inquiry, aligning much closer to the reform effort's purpose by the end of the course. This research has implications for teacher education programs designed to prepare preservice elementary teachers to teach inquiry-oriented science, especially how to help science teacher educators align their students' ideas about inquiry with reform efforts.

S6B.7.8 Student-teachers' Primary vs. Secondary Research Influences on Socioscientific Actions

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Erin Sperling, OISE, University of Toronto

ABSTRACT: Given the potential seriousness of 'socioscientific' issues, such as potential Climate Change and illnesses resulting from food additives, many jurisdictions have urged educators to engage students in decision making regarding these sorts of issues. Scholars and others argue, however, that students also need to take sociopolitical actions — such as lobbying of power-brokers — to address socioscientific issues. In the study reported here, we concluded — based on constant comparative analyses of qualitative data — that student-teachers' attachments towards sociopolitical activism may be influenced, albeit in complex ways, by findings from their primary and secondary research. Student-teachers' visions of the possible may serve them — and their future students — well, in the event that contextual factors evolve to support research-informed sociopolitical actions on socioscientific issues.

S6B.7.9 A Tool to Measure Planning-With-Curriculum Practices of Pre-Service Elementary Science Teachers

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Leslie Lancaster, University of Pittsburgh

Ellice Forman, University of Pittsburgh

Linda Deafenbaugh, University of Pittsburgh

ABSTRACT: Because elementary teachers have weak science content knowledge and many have negative feelings about the field of science and/or low self-efficacy with regard to teaching science (Appleton, 2006), they often rely heavily on

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prepared science curriculum materials to decide what to teach and how to organize their instruction (Mikeska, Anderson, & Schwarz, 2009). Given this reality of elementary teacher practice, those who work with pre-service elementary teachers (PSETs) must concern themselves with opportunities for PSETs to practice the critique of and planning with such materials. Although teacher educators at various institutions have developed frameworks that help PSETs practice this work, we are unable to describe generalizations about outcomes across contexts. Additionally, many of the context-specific learning tools that emerge from this design research work drive the research, therefore, making it difficult for other researchers to appropriate them to measure teacher practice in other contexts. To address these two research problems, we drew upon the work of Grossman, et al. (2009) to develop a tool for measuring particular PSET planning-with-curriculum practices across contexts (and not just within our institution). This paper discusses the rigorous and iterative development of this tool and what it can measure with regards to PSET planning-with-curriculum practices.

Strand 8: In-service Science Teacher Education**S6B.8 Poster Session B**

4:15pm – 5:15pm, Grand Sierra D

S6B.8.1 Impact of an Immersion Course on K-8 In-service Teachers' Understanding of Implementing Reformed Teaching Practices

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Peter Garik, Boston University

Charles Winrich, Boston University

Donald Derosa, Boston University

Andrew Duffy, Boston University

Manher Jariwala, Boston University

Russell Faux, Davis Square Research Associates

Nicholas Gross, Boston University

Bennett Goldberg, Boston University

Glenn Stevens, Boston University

ABSTRACT: The School of Education and the Departments of Mathematics and Physics at a research university together offer K-8 teachers' an immersive professional development course in science. The principal objectives of the course are to improve participants' content knowledge, self-efficacy in science, and understanding of reform teaching practices. To measure teachers' changes in their understanding of reformed practices, lesson plans developed prior to the course were compared to curriculum units designed at the end of immersion. To analyze changes in reformed teaching a rubric based on the Reformed Teaching Observation Protocol was developed for this study. Significant gains ($p < 0.01$) were found in teachers understanding of using reformed teaching in their lesson plans. STEBI-A also showed significant ($p < 0.02$) gains in teacher's PSTE. Correlations between pre and post-STEBI-A with post lesson scores were not significant 0.567 ($p=0.069$) and 0.552 ($p=0.063$). We believe this to due to our small sample size ($n=12$). However, the results suggest that teachers with high PSTE are more likely to write inquiry lesson plans, and therefore more likely to engage in reform teaching. This further suggests that to support the implementation of reform teaching we need to improve teachers' sense of self-efficacy.

S6B.8.2 Supporting Elementary Teachers' Evaluation and Adaptation of Science Curriculum Materials: The PIESC3 Professional Development Model

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Kimberly Gasaway, Davenport Community Schools

Mandy Biggers, University of Iowa

Laura Zangori, University of Iowa

ABSTRACT: Contemporary science education reform emphasizes engaging students in science as inquiry to best promote their learning. However, elementary teachers face many challenges engaging their students in inquiry-based science and often have to adapt their science curriculum materials to do so. The purpose of this presentation is to

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present a novel professional development model through which elementary teachers in a large, urban, high-needs school district will learn how to adapt their existing science curriculum materials to better engage students in science as inquiry. The 3-year PIESC3 (Promoting Inquiry-Based Elementary Science through Collaborative Curriculum Co-Construction – pronounced “pisc3”) professional development program will engage these elementary teachers in evaluation, planning, and instruction to learn about the teaching and learning of science as inquiry; learning to use this knowledge to feasibly adapt existing, district-specific science curricular resources to design inquiry-based planned instruction; analyzing their own teaching and evidence of student learning; and using this evidence to better support students’ science learning through classroom inquiry. We present tenets of the PIESC3 model, findings from the literature review that ground its design, elements of the program evaluation and research design, as well as insights into fostering and maintaining the multi-institution partnership in which the project is based.

S6B.8.3 A Comparison of Exemplary Biology, Chemistry, Earth Science, and Physics Teachers' Goals, Enactment, and Conceptions of Inquiry

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J. Randy McGinnis, University of Maryland, College Park

ABSTRACT: Teachers’ use of inquiry has been studied largely without regard for the disciplines in which teachers practice. As a result, we lack a detailed theoretical understanding of the role of discipline in shaping teachers’ conceptions and enactment of inquiry. In this study, conceptions and enactment of inquiry for 60 National Board Certified Science Teachers (NBCSTs) across the secondary science disciplines of biology, chemistry, earth science, and physics were investigated. A situated cognitive framework guided the study. Through the analysis of portfolio text (n=48) and participant interviews (n=12) themes emerged for participants’ goals, enactment, and conceptions of inquiry. Findings suggested that disciplinary differences exist between NBCSTs’ goals, enactment, and conceptions of inquiry. Further, individuals teaching in more than one discipline often held different conceptions of inquiry depending on the discipline in which they were teaching. A key implication was the need to consider the context of discipline in studying teachers’ goals, enactment, and conceptions of inquiry.

S6B.8.4 Improving Indigenous Schools: Effectiveness of a Field-based Professional Development Program in Rural Schools

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ABSTRACT: Narrative inquiry was used to investigate the success of a field-based PD program that visited 10 schools located at remote and rural Indigenous communities. A mentor traveled between the schools and worked with teachers, and introduced activities from an Energy and Change science resource kit using a classroom modeling approach. The kit was developed by a science museum and included hands-on activities that engaged students, provided ways to improve literacy and numeracy, allowed for a range of ability levels and was culturally appropriate. Specifically, the research investigated the kit’s relevance and ease-of-use, the PD needs of teachers, and identified factors that assist or hinder field-based PD. Information was collected by the mentor/researcher who maintained a journal, wrote field notes, and interviewed the program’s developers and the participating teachers. Findings indicated that the modeled lessons using the resource kit were beneficial for teachers. However many teachers had little content knowledge and limited their teaching to activities “that work”. Delivering a field-based PD was difficult because of the driving distances between isolated communities. A recommendation was made to extend the PD into a longer program with training in regional towns and followed with a mentor visiting schools.

S6B.8.5 Science Teachers' Initial Conceptions of 21st Century Skills and Their Implementation in Grade 3-8 Classrooms

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Christian Jurado, Stevens Institute of Technology

ABSTRACT: Science and engineering education are seen as promising vehicles to promote 21st century skills in the classroom because they are not only a body of accepted knowledge, but also involve processes that lead to knowledge. In this Mathematics and Science Partnerships project, 20 Grade 3-8 science teachers in 11 schools in New Jersey are taking part in a professional development program that uses science inquiry and engineering design process to cultivate

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specific 21st century skills in their classrooms. In this paper, we report on the teachers' initial conceptions and implementation of 21st century skills in their science classrooms based on clinical interviews collected during the first month of the program. Analysis of interviews indicated that teachers identified critical thinking and problem solving, communication, information technology, and comprehensive reading and listening as important skills for their students to learn. Very few teachers mentioned creativity and collaboration, and none mentioned innovation as skills cultivated by science inquiry and the engineering design process. In terms of classroom implementation of 21st century skills, teachers mentioned solving problems in groups, conducting laboratory experiments, teacher-led discussion, and Internet-based projects as ways to promote these skills.

S6B.8.6 Impact of a New Master's Program for K-8 Teachers on Their Knowledge and Practices

Yasemin Copur, ycopur2@illinois.edu

Hatun Zengin

Barbara Hug

ABSTRACT: We present a description of a new program designed by a state university in collaboration with a partner school district located in a middle-sized urban city. The impact of this two year old program on teachers' content knowledge, pedagogical content knowledge and pedagogy has become evident through content knowledge assessments in science and math, as well as teacher surveys, classroom observations, student surveys, and SEC data as reported by the teachers. This poster discusses the effectiveness of a master's program whose purpose is specifically to improve teachers' science and math content knowledge. The range of teaching strategies used by our participant teachers will be discussed within the context of teachers' perceived impact of the program on their knowledge and teaching practices. The analysis of classroom observations provides insight into teachers' classroom practices and climate, with particular attention paid to teachers' emphasis on students' ability to understand the connections between concepts. Student survey data help us see how the students perceived the practices of their teachers, while the SEC data help us understand how the teachers perceived and reported their own practices.

S6B.8.7 Using Physics Education Research Literature in Teacher Professional Development

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Peter Garik, Boston University

Margaret D. Nolan, Boston University

Yann Benétreau-Dupin, Boston University

Andrew Duffy, Boston University

Arthur Eisenkraft, University of Massachusetts - Boston

Luciana Garabayo, University of Texas - El Paso, Department of Philosophy

Nicholas Gross, Boston University

Manher Jariwala, Boston University

Russell Faux, Davis Square Research Associates

ABSTRACT: The School of Education and the Department of Physics at a large urban research university offer interdisciplinary courses for high school physics teachers. The courses combine physics content, the conceptual history of physics, and readings from the physics education research literature. The research literature is read following instruction in physics content, so the participants can consider the research in the light of their own challenges with the material. The participants report increased use of research results in their teaching, which is also evident in lesson plans prepared as part of the coursework. The most common inclusion of research results in the participants' lesson plans is the addressing of their students' existing knowledge. Explicit exposure to physics education research findings along with physics content is an effective way to increase the impact of research findings on teacher practice.

S6B.8.8 Qualitative Indicators of Successful Induction: Case Studies of Three Beginning Secondary Science Teachers' Induction Experiences

Angela W. Webb, University of North Carolina at Greensboro, awwebb@uncg.edu

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ABSTRACT: Though it has been demonstrated quantitatively that beginning secondary science teachers benefit from induction activities such as mentoring and that such activities impact teachers' knowledge and beliefs (e.g. Luft, Lee, Fletcher, & Roehrig, 2007; Luft & Patterson, 2002; Luft, Roehrig, & Patterson, 2003), more research is needed to describe and understand the qualities of induction experiences that make them effective in supporting and retaining beginning secondary science teachers. Additionally, it is important to consider measures of successful induction that go beyond retention statistics. Using Wenger's (1998) modes of belonging (engagement, imagination, alignment) as sources of identity, this paper describes the induction experiences – both formal and informal – of three beginning secondary science teachers with respect to meaning making and identity-in-practice to make the following arguments: First, these cases demonstrate that beginning secondary science teachers value aspects of induction that allow them to collaborate with other teachers. Second, general, large scale orientations and beginning teacher meetings are not as impactful for these beginning secondary science teachers. Third, these beginning secondary science teachers value science-focused aspects of their induction.

Strand 9: Reflective Practice

S6B.9 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.9.1 An Elementary School Teacher's Reflection on Implementing Constructivist Instruction in Science Classroom

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Jing-Ru Wang, National Pingtung University of Education, Pingtung, Taiwan

ABSTRACT: The main purpose of this paper was to describe how the author(1) changed his teaching beliefs and science instruction through participating in a cooperative action research, which is conducted by the author(2). Narrative inquiry was adopted to explain and interpret how the author(1) changed his belief about teaching science and his experience of implementing the constructivist instruction in Taiwan island. The current research report involved two parts. First, how the author(1) developed his teaching belief was presented. Then, the process of transforming author's(1) teaching belief into practical teaching was provided. In conclusion, the author(1) retrospected to his personal experiences in understanding of constructivist instruction, which reflected the process of how a novice teacher became an expert teacher. Finally, the authors provide strategies for the design of science teacher professional development.

S6B.9.2 Avenues for Chemistry Teachers' Reflection: Comparing a Video Annotation Tool to Written Journals

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Steve J. Oliver, University of Georgia

ABSTRACT: This study investigated teacher reflection by comparing "written journal entries" that chemistry teachers kept during student-led instructional sessions to "reflective comments" that they made while watching video-recorded classroom moments through Video Analysis Tool (VAT). The context of the research was a teacher research project in which three chemistry teachers conducted classroom research on an innovative inquiry-based instructional strategy titled Community Based Inquiry Lessons. The teachers kept written journals in the classrooms as well as made video-recordings of the instructional sessions and reflected on these video in collaboration with the researchers. Those journal entries and reflective comments recorded on the VAT were collected as a major data source. Data were analyzed by using inductive analysis utilizing a grounded theory approach and constant comparative methods. The comparison between teachers' journal entries and their reflective comments on VAT provided supporting evidence that video-based reflections create a richer stimulus for teachers' examination of their own classrooms. The findings claim that video-based reflection is an effective strategy for developing teachers' reflectivity in terms of both the substance and quantity of their reflections. The study provides science teacher educators with a model for supporting teachers' critical reflection.

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Strand 10: Curriculum, Evaluation, and Assessment

S6B.10 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.10.1 Multimodal Generative Learning Theory: A New Model of Evaluating Representations of Science Principles

Suzanne M. Donnelly, Longwood University, donnellysm@longwood.edu

ABSTRACT: This poster presents a new conceptual framework for use in studying and evaluating curricular materials in the sciences. This approach explicitly combines the cognitive perspective of generative theory and recent developments in multimodal learning to characterize representations of science concepts which incorporate several modes of presentation. A multimodal generative learning theory (MGLT) model is proposed, offering new insights into how learners interpret, integrate, and transform instructional material to produce their own understandings, providing a basis for evaluating curricular materials based on the characteristics of representations of science content which best facilitate learning.

S6B.10.2 Teaching and Learning Concepts of Scientific Evidence: A Design-based Research and Development Study

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Kara Naidoo, New York University

Anna Stetsenko, CUNY Graduate Center

Catherine E. Milne, New York University

ABSTRACT: In the study presented here we report on progress towards understanding children's developing conceptual schemas for scientific evidence. We are using a design-based research approach to curriculum development where we record all of the events in the classroom to study how elementary school students learn about evidence. Our feasibility studies are designed to learn what kinds of teaching-learning actions create confusion among students and which help move children forward in their thinking about evidence. In this paper presentation we focus on factors influencing how 4th grade children develop concepts of evidence during the first cycle of our curriculum design and implementation.

S6B.10.3 Pilot-testing the Astrobiology in Secondary Classrooms (ASC) Curriculum: Focusing Upon Diverse Students and Teachers

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Todd P. Gary, Tennessee State University

Susan Kuner, Topaz Canyon Group, LLC

Doug Robinson, Dragonfly Enterprises, Inc.

Judy Butler, Dragonfly Enterprises, Inc.

ABSTRACT: The Minority Institution Astrobiology Collaborative (MIAC) began working with the NASA Goddard Center for Astrobiology in 2003 to develop curriculum materials for high school chemistry and Earth science classes based on astrobiology concepts. The Astrobiology in Secondary Classrooms modules currently under development emphasize interdisciplinary connections in astronomy, biology, chemistry, geoscience, physics, mathematics, and ethics through hands-on activities that address national educational standards. Field-testing of the Astrobiology in Secondary Classrooms materials occurred over three years in eight US locations, each with populations that are underrepresented in the career fields of science, technology, engineering, and mathematics.

S6B.10.4 The Case of the Missing Sun: An Analytical View of Water Cycle Representations

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Lloyd H. Barrow, University of Missouri-Columbia

ABSTRACT: Using the lens of Visual Literacy (VL), researchers examined water cycle representations in twenty-one high school science textbooks to discover what was found in each diagram, and then did a comparison to find out if any component of the water cycle was missing from each textbook's representation. VL is an active learning process in which an individual uses past experiences to analyze images with new images to construct knowledge (Sinatra, 1986).

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Researchers found that textbooks images in this study did not meet all the criteria that should be found water cycle representations, and critical components like the inclusion of the sun and the process of condensation were missing.

S6B.10.5 Persistent Student Difficulties in Understanding the Particulate Nature of Matter

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Julianne Crowley, Curtin University of Technology

Mauro Mocerino, Curtin University

A.L. Chandrasegaran, Curtin University

ABSTRACT: In chemistry the idea that matter is composed of small, discrete, invisible particles is a fundamental concept. This research sought to investigate any changes in understanding of particulate nature of matter concepts as a result of different years of schooling using a diagnostic instrument administered to students in Grade 9 Science, Grade 11 Chemistry, 1st year university bridging chemistry course and pre-service science teachers. The particulate nature of matter concepts were categorized under (1) intermolecular spacing in solids, liquids and gases, (2) changes of state and intermolecular forces and (3) diffusion in liquids and gases, using 12 two-tier multiple-choice items that required students to choose the response to the first tier about the content and a response about their explanations for their selection of particular response to the first tier. The total instrument had a Cronbach alpha reliability of 0.76. The results showed similar outcomes for each of the student groups and raise questions about the teaching of the particulate nature of matter as almost no students surveyed at any level were able to correctly answer a series of items relating to individual concepts with correct reasons. This concept requires a more enriching and slower development than is traditionally given in the junior science classroom.

S6B.10.6 Computerized Formative Assessment in Secondary Science: Toward a Customised, Individualized Learner-centred Program of Learning

James F. Law, Curtin University, famlaw@xtra.co.nz

David F. Treagust, Curtin University of Technology

ABSTRACT: The purpose of this research was to develop, implement and evaluate a custom-made on-line two-tier diagnostic instrument for use as formative assessment with distance education secondary students to ascertain their conceptual level of understanding so that they could be provided with appropriate customized learning materials in science. In this electronic teaching environment, two-tier diagnostic tests were developed and used to provide a basis for individualization of student science learning programs. Units of learning in science were selected for students in grades 9, 10 and 11 depending on their conceptual levels. On the basis of this information, a customised, learner-centred program of learning was designed to enable students to reach their potential over an appropriate period of time. The instrument provides evidence-based formative data enabling action to be taken to modify misunderstandings of scientific concepts essential for further learning in science. The online two-tier items have the potential to be used singly or in groups by teachers or by students in self-assessment to provide formative data to inform the next steps in the learning process. An item bank developed from online two-tier diagnostic items of the type used in this instrument has the potential to help students in the 21st century learning environment to understand scientific concepts.

S6B.10.7 Students' Alternative Conceptions About Alternative Energy

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Hih Hardimah Hj Mohd Said, Universiti Brunei Darussalam

Marlizayati Hj Johari, Universiti Brunei Darussalam

David F. Treagust, Curtin University of Technology

ABSTRACT: All people need to understand alternative energy so that decisions on future energy practices and policies can be made more effectively and sustainably. This study investigated students' understanding of and alternative conceptions about alternative energy in terms of solar, nuclear, hydrogen fuel, geothermal, wind, hydropower and ocean thermal using a designed two-tier questionnaire. Year 10-11 students (n=495) showed superficial knowledge and poor understanding of alternative energy (mean= 8.7, max=30). The features of the designed instrument and alternative conceptions of alternative energy that are science related and identified are

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reported. The results of further development and improvement of the instrument to ensure appropriate validity, reliability, discriminatory, difficulty and readability are reported. The findings draw attention to the strengths and weaknesses of the curriculum that the students follow and the need for educators to highlight which concepts are best understood and which need to receive more emphasis. Further utilisation of the improved instrument to improve an understanding of alternative energy is recommended. Implications from this study include the need for promoting understanding of alternative energy with learning in an interdisciplinary manner so that better decisions on future energy practices and policies can be made.

S6B.10.8 Students' Understanding of Light Propagation and Visibility of Objects in Different Contexts in Singapore and Korea

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David F. Treagust, Curtin University of Technology

Alexander Kauertz, Weingarten University of Education

ABSTRACT: A large scale quantitative study involving 1,233 Korean students and 1,149 Singapore students from Years 7 to 9 was undertaken to evaluate their understanding of fundamental optics concepts. The Light Propagation Diagnostic Instrument (LPDI) consisted of two concept groups in two different contexts, using four pairs of two-tier multiple-choice items. Research findings showed that 1) four general alternative conceptions about light propagation were held by 10%-30% of the students across all school years from both Singapore and Korea. Most alternative conceptions of light propagation were not context-dependent. 2) Except for gender, each of the variables, country, school and school grade, had an influence on students' basic optics conceptions. However, the strength of variables was weak except "school" ($\text{Eta}^2=0.29$) in Singapore while it had no impact in Korea. "School grade" also affected students' conceptual understanding in Singapore but the strength of variable was weak ($\text{Eta}^2=0.02$). However, "School grade" did not affect Korean students' optics conceptions. The research implications indicated that 1) there was weak conceptual progression across the school grades in fundamental optics concepts and 2) students needed more opportunities to compare concepts in different contexts in order to facilitate their conceptual development of the fundamental underlying concepts.

S6B.10.9 Cognitive Accessibility Levels of Turkish Level Determination Examination: Living Things and Life Learning Area

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ABSTRACT: In this study, it was aimed to determine cognitive accessibility levels of questions asked in large-scale that are strongly necessary to be prepared with the consideration providing opportunity to present every kind of possible student proficiencies with the assumption of availability to evaluate directly group of responders that has various specifications. For the realization of this aim, document analyze method were conducted in order to investigate cognitive accessibility levels of "Living Things and Life" learning area questions asked in the science and technology test placed in 2010 Level Determination Exam which is one of the large-scale, central examinations in Turkey for high school entrance by using Accessibility Rating Matrix (ARM). Obtained data through ARM were revealed that only one of the questions has maximally accessibility for nearly all test-takers, 41.2% of the questions have maximally accessibility for most test-takers, 41.2% of the questions have maximally accessibility for some test-takers, and 5.9% of the questions have inaccessibility for many test-takers. Consequently, question of large-scale examinations also need to be arranged in accordance with the principles derived from the cognitive load theory as well as the universal design principles starting from the beginning stage of the question preparation for better assessment results.

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Strand 11: Cultural, Social, and Gender Issues

S6B.11 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.11.1 Re-presenting Gender Differences in Science Achievement

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Jane Kahle, Miami University

Yue Li, Miami University

Constance Blasie, University of Pennsylvania

ABSTRACT: This paper examines the gender and racial differences in student science achievement whose teachers had graduated from a National Science Foundation funded Mathematics Science Partnership project. The project focused on providing standards-based, pedagogically appropriate, content-based professional development to middle school science teachers. Results showed how achievement differences between student groups can be misleading if gender is ignored. Teachers' use of standards based practices such as inquiry-based instruction, complex questioning, and collaborative learning decreased achievement gaps between student groups. When examined by gender, there was no achievement differences between girls but differences existed between boys.

S6B.11.2 Equitable Written Assessments for English Language Learners: How Scaffolding Helps

Somnath Sinha, University of Missouri, ssqh9@mail.mizzou.edu

Marcelle A. Siegel, University of Missouri

Deepika Menon, University of Missouri

Nattida Promyod, University of Iowa

Cathy Wissehr, University of Arkansas

Kristy L. Halverson, University of Southern Mississippi

ABSTRACT: Research shows that written classroom assessment items are not well designed to meet the cognitive demands of learning for linguistic minorities. This study investigated the effects of the use of scaffolds in written assessments for both English language learners (ELL) and native English speakers from two middle schools. Two versions of assessment tasks, with scaffolds designed for ELL and without scaffolds, were developed for the study. Data sources included think aloud protocols, students' written responses to assessment tasks, and post-assessment interviews. Audiotaped data was transcribed. Using an equitable assessment framework, we analyzed and compared the responses of ELL and native English speakers for the two versions of assessment tasks. Data analyses showed that both ELL and native English speakers benefited with the use of scaffolds. The scaffolds helped because students were able to comprehend easily, respond correctly, and in terms of visualization and organization of their thoughts.

S6B.11.3 The Influence of Teacher-Scientist Partnerships on Urban Middle School Students' Science Learner Characteristics

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ABSTRACT: This study investigates urban middle school teachers' beliefs about their students' ability to succeed in science, and the extent to which those beliefs' were influenced by their partnerships with amateur or professional astronomers. Twelve urban middle school science teachers participating in the program, Project ASTRO, were interviewed before and after participation using semi-structured, in-depth interview techniques. The findings suggest that prior to participation that teachers believed that the student characteristics that are necessary for high achievement in science and astronomy in particular include specific qualities of mind, student dispositions, and prior knowledge and experiences with the subject area. These teachers further viewed their own students as largely lacking in those characteristics needed for success in science. After participation, teachers believed that their partnerships with amateur or professional astronomers largely influenced their students' dispositions and enhanced their experiences with the subject area. The study also revealed that the partnerships had relatively little influence on urban middle school teachers' beliefs about their students' qualities of mind. The implications of these findings suggest that partnerships

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with scientists, such as amateur and professional astronomers, might help urban middle school students to experience a more culturally relevant astronomy curriculum and promote their engagement with science.

S6B.11.4 How Do Minorities within the Minority Identify with Science and Engineering? A Focus on Middle School Students' Identity Negotiations Regarding Science

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Roxanne Hughes, Florida State University/National High Magnetic Field Laboratory

ABSTRACT: Using Gee's (2000-1) conception of identity and Lave and Wenger's (1991) idea of community of practice, the authors identify the science identity negotiations of ten middle school students who participated in a science summer program. The authors focused on students of varying genders, ethnicity, and race because of the underrepresentation of these individuals in science. The interactions with scientists during the camp improved all of the students' ability to see themselves as possible participants in the science community of practice. However, for some other aspects of their identity conflicted with their abilities to see themselves as full participants.

S6B.11.5 How Parent and Child Gender Influences Children's Attitudes and Problem Solving Skills in Science

Susannah K. Sandrin, Arizona State University, Susannah.Sandrin@asu.edu

Katherine J. Short-Meyerson, University of Wisconsin - Oshkosh

ABSTRACT: We examined the role of parental influence on elementary school age children's science attitudes, interests and problem-solving strategies, within the framework of Vygotsky's (1978) and Rogoff's (1990, 1995) sociocultural theories and Bronfenbrenner's (1995, 2004) ecological systems theory. We were interested in how parental influence and child behavior varied with parent and child gender, as informed by Bem's Gender Schema Theory (1981). Our research questions below include whether there was a difference with regard to parent and/or child gender for each question: 1. What are parents' roles in solving science problems with their early elementary school-age children? 2. Which discipline of science problems do parents and their early elementary school-age children prefer? 3. What are early elementary school-age children's approaches to solving science problems with their parents? A mixed method approach was used to analyze video and audio tapes from 13 parent-child dyads as they solved science problems (including 6 physical and 5 life) together. Results indicated that there were differences in helping behaviors between mothers and fathers, and that child problem solving strategies and the amount of encouragement offered by parents varied by child gender. Additionally, results from a parent demographic/attitudinal survey and child interview are discussed.

S6B.11.6 Street Medicine: A Case Study of Articulations of Technoscience, Education, Inquiry, and Social Justice in Non-school Settings

Matthew Weinstein, University of Washington-Tacoma, mattheww@u.washington.edu

ABSTRACT: This paper examines the science education practices of a network of medics dedicated to supporting social justice works. This network is known as the street medics. The paper describes the variety of media the medics use and content that they provide to support resistance to corporate globalization, immigration policies, and militarization. The paper examines their work as popular, in the Freireian sense of the word, science education. The paper also analyzes their work as one of four projects "articulating" science and publics in specific ways, ways that provide contrasting models of scientific authority, science content, educational practice, and participation in science. The four projects I call school science, citizen science, popular science, and ciencia popular, the medics being my exemplar of the latter. Through this contrast the paper clarifies the limits of social justice oriented science education in schools and informal settings as well as the nature of science when developed towards radical democratic transformation.

S6B.11.7 Effect of Culture on High-School Students' Question-Asking Ability Resulting from an Inquiry-Oriented Chemistry Laboratory

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Rachel Mamlok-Naaman, Weizmann Institute of Science

Avi Hofstein, Weizmann Institute of Science

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ABSTRACT: In order to cope with complex issues in the Science-Technology-Environment-Society (STES) context, one must develop students' high-order learning skills, such as question-asking ability (QAA), critical system thinking (CST), evaluative thinking (ET), decision-making (DM), and problem-solving capabilities (PSC) within science education. In this study we are concerned with evaluating the effect of student-teacher interaction - which is regulated by culture and traditions - on the QAA in science classroom in general, and specifically in our case, in chemistry laboratory classroom. We take Arab and Jewish sectors, that are according to the literature different in their culture and tradition, as a model for our investigation. Specially developed and validated tools, including a novel practical test and an adapted article followed by a questionnaire for evaluating QAA, were administered to the research student population and the responses were analyzed quantitatively. Observations were conducted in order to better understand the quantitative results that we got. Our findings indicate that there was a difference in the QAA between the two sectors. According to our findings, we assume that cultures, tradition, norms, social structure, modes of living, and related factors play a significant role as far as the development of students' QAA, and apparently, any intended attempt targeting the QAA paradigm shift must take into consideration the multicultural context within which it is to be implemented.

S6B.11.8 Collaborating to Transform Urban Science Education: Theory and Methods

Kenneth G. Tobin, CUNY, ktobin@gc.cuny.edu

ABSTRACT: The adoption of new theoretical lenses sheds fresh light on the ways in which persons experience social life and make sense of participation in their lifeworlds. I consider possibilities for a refreshing new era of research and scholarship in science education—especially in regards to the interfaces between research, policy and professional practice. In relation to a 15-year program of research in urban science education I present sociocultural frameworks to improve the quality of research, changing foci and research methods, and affording concomitant changes in issues identified as salient. Teaching and learning were theorized as culture and associated dialectical theory, models that previously emphasized human agency included passivity, and emotions were framed as ever-present parts of science education. I present a review of research on cogenerative dialogue (cogen) as an example of a collaborative approach to science education that holds the promise of overcoming many persistent problems. Participants in cogen expanded their agency and learned how to collaborate with others who differed from them socially and culturally. Research on cogen highlights the potential of building schooling around collaboration, rejecting the hegemonic axiom that effective science education necessitates conformity to metaphors such as competition, individualism, and control over others.

Strand 12: Educational Technology

S6B.12 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.12.1 Analysis of Greenhouse Effect Simulation Implementation in 8th Grade Science Course

Edward C. Cohen, Rutgers University, ecohen@pway.org

Timothy Zimmerman, Rutgers University

ABSTRACT: The purpose of this pilot study was to examine how students use a greenhouse effect simulation embedded within a technology-mediated science curriculum. This middle school study was conducted because there is little research on how students use simulations in Earth Science. JING screen capturing software was used to analyze student simulation usage along with interviews, observations, and pre/post tests. The JING capturing of simulation manipulation and auditory information provided insight as to: 1. What lead students to adjust the variables in the ways or amounts they did. 2. Their scientific method and beliefs about if this activity constituted science. 3. The way in which they used the graph or ease of representation to add to their scientific understanding. One of the major strengths of the simulation was student engagement and motivation while using the simulation aspect of the curriculum. Student's thinking was made visible with the assistance of the simulation. Their viewpoints varied as to the use of simulations as a scientific endeavor. Students changed their thinking throughout the curriculum, but mixed responses still existed at the

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end of the study. Strengthening the prior nature of science instruction to include virtual modeling and simulations may prove to be beneficial.

S6B.12.2 Children Learning Technological Design and Engaging in Problem Solving with an ALERT Robot

Katherine Nilsen, University of California, Santa Barbara, knilsen@education.ucsb.edu

Danielle B. Harlow, University of California, Santa Barbara

ABSTRACT: There is a growing national focus on STEM education, but unfortunately young children rarely have the opportunity to participate in activities related to technology and engineering in the classroom. Using a constructionist framework, we examined how first grade students used skills associated with technological design through programming a physical robot. In particular, our research focuses on the process of problem solving based on the National Science Education Standards (NRC, 1996) abilities of technological design for grades K-4. Students were assigned into a pair or trio, and participated in three sessions with the robot. Sessions included playing robot, free play, and prescribed tasks. Transcripts from videotape records were analyzed qualitatively. Our findings indicate that students engage in the four stages of problem solving: identifying problems, proposing solutions, implementation, and evaluation. Results from our case study support the need for and benefits of K-12 engineering education.

S6B.12.3 Leveraging on Interactive Animation to Facilitate Student Science-Process Skill Learning

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Chun-Yen Chang, National Taiwan Normal University, Taipei, Taiwan;

ABSTRACT: In this study, a set of computer-based multimedia were designed to assist students in learning topographic measuring. Twenty-seven students were randomly assigned to different multimedia groups, including Static Graphics (SG), Simple Learner-Pacing Animation (SLPA), and Full Learner-Pacing Animation (FLPA). The interactive design of FLPA allowed learners to physically manipulate the virtual measuring mechanism, rather than passively observe dynamic or static images. The results of a one-way ANOVA analysis on students' self-report cognitive load ratings, practical performance scores, and instructional time-spans revealed that there were statistically significant differences along with large effect sizes of cognitive load ratings and performance levels ($f = 0.69$ and $f = 0.76$, respectively) between groups, but there was no significant difference in instructional time-spans between groups ($p = 0.637$). The post-hoc tests indicated that FLPA imposed less cognitive load on students than did SG ($p = 0.007$), and FLPA fostered better learning outcomes than both SLPA and SG ($p = 0.004$ and $p = 0.05$, respectively). Overall, the media format of FLPA had the best efficiency for facilitating learning. It suggested that the interactive design of FLPA could serve as the aid to ease students' cognitive load on constructing visual representations.

S6B.12.4 Prediction and Explanation as Design Mechanics in Conceptually-Integrated Digital Games to Help Players Articulate the Tacit Understandings they Build Through Gameplay

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Mario Martinez-Garza, Vanderbilt University

Brian C. Nelson, Arizona State University

Kent J. Slack, Arizona State University

Cynthia M. D'Angelo, University of Wisconsin

ABSTRACT: Several games have been developed in recent years with a focus on engaging players in inquiry; these games have proven successful in helping players learn about inquiry and the science concepts involved. A few games, by contrast, have focused on integrating the science learning directly into movement and navigation through the game itself. A significant challenge in these games, is that the learning tends to remain at a very tacit embodied level. This poster paper discusses the potential of harnessing prediction and explanation as design mechanic in digital games to help players articulate the tacit understandings they are building through gameplay, as well as a framework for integrating these mechanics into a learning game.

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Strand 13: History, Philosophy, and Sociology of Science

S6B.13 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.13.1 The Nature of Scientific Laws in Biology and Chemistry: Implications for Science Curriculum and Instruction

Zoubeida R. Dagher, University of Delaware, zoubeida@udel.edu

Sibel Erduran, University of Bristol

ABSTRACT: The teaching of science remains disconnected from interdisciplinary studies of chemistry and biology despite decades-long reform efforts to link science to its historical, philosophical and sociological contexts. Efforts to restore the connections have ranged in focus and scope sometimes emphasizing explicit reference to general characteristics of scientific knowledge or a range of critical inquiry practices. Research in this area has led to valuable insights about what students are able to learn about the nature of science and the conditions that facilitate and hinder that learning. However, extant nature of science accounts can be enriched by a consideration of the epistemologies of the disciplines. In this paper we focus on 'laws' in biology and chemistry contexts to illustrate the potential of discipline-specific discussions on adding depth and meaning to science curriculum and instruction.

S6B.13.2 Cross-Cultural Epistemological Orientations to Socioscientific Issues

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

Mitch Ruzek, University of South Florida, USA

Wardell A. Powell, University of South Florida, USA

Jeff Orasky, University of South Florida, USA

Scott Applebaum, Palm Harbor University High School, USA

Chi-Chin Chin, National Taichung University, Taiwan

Shu-Sheng Lin, National Chiayi University, Taiwan

Cedric Linder, Uppsala University, Sweden & University of the Western Cape, South Africa

Anne Linder, Uppsala University, Sweden

Mark Herbert, University of the Western Cape, South Africa

ABSTRACT: The purpose of this investigation was to examine, from a cross-cultural perspective, students' epistemological patterns of reasoning about socioscientific issues (SSI), and to identify potential interactions of cultural and scientific identity. Mediating factors associated with students' argumentation and discourse about SSI, as well as the public's understanding of science, has been identified as an important area of investigation in the field of science education. This mixed-methods design included over 300 students from Jamaica, South Africa, Sweden, Taiwan, and the United States. Students responded to instruments designed to assess their epistemological conceptualizations and justifications related to distributive justice, allocation of scarce medical resources, and epistemological beliefs over five dimensions related to scientific knowledge. Four iterations of a coding scheme produced over 97% inter-rater agreement for four independent coders. Results indicate there is a consistent trend toward epistemological congruity within a given culture, and distinct emphases on how scientific knowledge is constructed among countries. Thematic Categories are compared and contrasted and connections to a model of socioscientific reasoning and implications for research and pedagogy are discussed.

Strand 14: Environmental Education

S6B.14 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.14.1 Crafting a Balanced Message: Negotiating the Values and Goals of Climate Scientists Engaged in Outreach

Elizabeth M. Walsh, University of Washington College of Education, ewalsh2@u.washington.edu

Philip Bell, University of Washington College of Education

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ABSTRACT: The Climate Change Group (CCG) is an organization at a major urban university that promotes interdisciplinary research, collaboration and education. In response to increasing interest in, and demand for, knowledge about climate science, the professors, graduate students and staff in the CCG have become engaged in outreach. Using ethnographic methods, this study explores the challenges the CCG faces in constructing climate science messages for outreach activities. These scientists seek to balance three motivating drivers: promoting an understanding of scientific knowledge, protecting or creating the authority and integrity of the climate science community, and connecting to or conveying emotion. The goals of outreach activities are informed by how the climate scientists wish to position themselves within the broader socio-cultural discussion.

S6B.14.2 Families Visiting an Environmental Center: Understanding Ecological Relationships

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

Lucy R. McClain, Pennsylvania State University

Li-Chun Wang, Pennsylvania State University

Sameer Honwad, Rutgers, The State University of New Jersey

ABSTRACT: Using a sociocultural framework for learning, this analysis examines the knowledge of ecological relationships that families used during their nature center visit. Data comes from one task-based interview, observation of 22 informal programs, and responses from a short cognitive assessment. Understanding the food chain was a challenge for visitors, especially adults. During the interviews, respondents represented ecological relationships (i.e., predator-prey) yet struggled to explain how these relationships were part of a larger system. Multiple groups could not explain the food chain in terms of the birds onsite, but instead used non-local animals (i.e., lions) as food chain examples. This work has implications for learning theory and the design of informal environments.

S6B.14.3 Embedding Education for Sustainability into Pre-Service Primary Teacher Education

Lyn C. Carter, Australian Catholic University, lyn.carter@acu.edu.au

Caroline J. Smith

Phil C. Clarkson

ABSTRACT: Against the background of the now urgent need for transitions to a sustainable future, this paper discusses pre-service education for sustainability (EfS/ ESD) within science education. Effective teacher education is a key enabler for EfS/ ESD and pre-service teachers require substantially more education in the area than they currently receive in most tertiary institutions. EfS/ESD is a complex, transformative and transdisciplinary field associated with particular pedagogies, content and processes and most effectively delivered through a whole-of-system approach. The Australian Sustainable Schools Initiative (AuSSI) provides a useful platform for considering pre-service EfS/ESD, tying in with EfS/ESD practice in an increasing number of Australian schools. This paper argues for pre-service teacher education for sustainability within science education and reports on a formal evaluation of embedding five AuSSI modules into the semester long second-year unit EDST 204 Science & Technology for Primary Teachers 2 within the Bachelor of Education degree for primary (elementary) pre-service teachers at the Australian Catholic University in Melbourne. The findings of this evaluation speak to the implementation of EfS/ESD more broadly within pre-service teacher education.

S6B.14.4 Girls and Going Green: Adolescent Girls and Their Understandings of Environmental Issues

Kimberly A. Haverkos, Miami University, haverkka@muohio.edu

Nazan U. Bautista, Miami University

ABSTRACT: There is a continuing interest in promoting awareness for environmental issues and environmentally responsible behaviors through increased access to environmental education. This access to environmental education may help increase girls' involvement in sciences and even encourage them to pursue science careers. The objectives of this qualitative study were to: 1) determine what girls know about environmental issues; 2) determine where/how their knowledge about environmental issues develops; and 3) how they come to make sense of those environmental issues. Using interview data collected with fifteen adolescent girls, major findings of this study revealed that girls' ability to make sense of environmental issues and to link local issues to global issues rely heavily on their personal experiences. Girls stated their trust in the information delivered by their teachers and were wary of the information delivered

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through media outlets and celebrities. Informal conversations in classrooms or with parents were also an important avenue for how girls came to understand environmental issues. Teachers must be equipped to take advantage of these conversations in order to increase the awareness and understanding of all their students around issues of environmental concern as well as develop connections between girls and science through environmental education.

S6B.14.5 Development of an Urban Environmental and Geoscience Place-based Curriculum Using Cogenerative Dialogue

Amy E. Defelice, City University of New York Graduate Center & Brooklyn Academy of Science and the Environment, amyferguson3@hotmail.com

Jennifer D. Adams, Brooklyn College-CUNY

Ishmael Akahoho, Brooklyn Academy of Science and the Environment

ABSTRACT: Abstract This research is the first part of an ongoing research study that utilizes collaboration of research scientists, educators, high school students, and community organizations to build a long-term sustainable program that will increase minority participation in the geoscience fields. This portion of the study focused on developing a critical place-based environmental studies curriculum based in the interests and voices of urban high school students. The curriculum is for a week-long study in a local urban park. Cogenerative dialogues were used to elicit student reflection about their previous learning experiences in the local park and determine how these and other learning experiences could be improved. Videotapes of cogenerative dialogues were recorded to foster student reflection and analyzed for emerging themes. Students involved in planning the curriculum and students who participated in the week-long learning experience felt included in the scientific community while being exposed to college faculty. Students felt encouraged to pursue science majors in college and developed a sense of stewardship for the local urban park. This research is a model for creating place-based curricula that focus on environmental and geoscience topics specific to local areas.

Strand 15: Policy

S6B.15 Poster Session B

4:15pm – 5:15pm, Grand Sierra D

S6B.15.1 Whose Nature is It?: Exploring The Nature of Engineering in Science Education

Catherine M. Koehler, Illinois Institute of Technology, ckoehler@iit.edu

ABSTRACT: In a rapidly changing technological world there is a fundamental shift in the composition of the workforce America needs to compete in a global market. Our nation's well-being depends upon how well we educate our children in science, technology, engineering, and math (STEM) because our economic and national security derived from technological creativity and global competition. Updating the most recent version of the National Science Education Standards, a Committee on Conceptual Frameworks for Science Education at the National Research Council has developed a new framework for science education standards. The most profound difference in this document is the emphasis on engineering design and the cross-cutting nature of the two disciplines, science and engineering. This study uses a qualitative methodology to examine the research question, what is the nature of engineering (NOE)? Using online survey software, academic and professional engineers' perspective about NOE were examined. Preliminary results of this survey indicate that engineers view NOE as being procedural, creative, goal driven, cost effective, applying scientific knowledge, constraint driven, need driven, multi-disciplinary, ethical, economical, detail oriented, influenced by society, politics, and safety.

S6B.15.2 Retaining Public High School Science Teachers: Current Practices and Challenges

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

ABSTRACT: This paper presents research findings for 50 sample schools (representing 1,333 high schools that offer science courses) selected to investigate the high school science teacher professional continuum in a U.S. state. Verbal analysis of principal interviews was used to categorize major themes specific to retention practices and retention challenges for science teachers. Findings indicate few retention practices and challenges specific to science teacher

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retention exist within these schools. Implications from this study suggest evaluating the relationships between these variables with teacher mobility across different school contexts will provide a better assessment of the current state of retention of high school science teachers.

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The Equity and Ethics Committee Sponsored Ssession

S7.1 Jhumki Basu Scholars Symposium: Global Sustainability and Public Understanding of Science -- The Role of Science Education in the International Community

8:30am – 10:00am, Antigua 1

Presider: Mamta Singh, Martin University

Discussant: Lisa Martin-Hansen, Georgia State University

Presenters:

Tapati Sen, Arizona State University

Ashraf Shady, Queens College, CUNY

Reizelie Barreto-Espino, Towson University

ABSTRACT: In this symposium, three winners of the 2010 NARST Equity and Ethics Committee's Jhumki Basu Scholarships present their research. The symposium showcases the work of scholars who are underrepresented in the science education research community. Using different theoretical frames and methodological approaches, each of these three scholars investigated issues of equity and ethics in the teaching and learning of science. Individually and collectively, their studies speak to the NARST conference theme: Global Sustainability and Public Understanding of Science – The Role of Science Education in the International Community. More specifically, Tapati Sen focused on the impact research experiences for science teachers had on their classroom instruction. She analyzed documents collected from teachers during the course of the Mathematics and Science Teaching Fellows (MSTF) program. Ashraf Shady investigated the role of cultural alignment in producing success in urban science education. His paper highlights a study he conducted during the 2006-2007 school year in a low performing middle school in New York City. Reizelie Barreto-Espino investigated changes in prospective teachers' knowledge of teaching science with an emphasis on evidence-based explanations. The scholar contextualized results in light of available literature on teaching science in urban contexts.

Strand 1: Science Learning, Understanding and Conceptual Change

S7.2 Interventions Supporting Student Learning in the Physical Sciences

8:30am – 10:00am, Curacao 1

Presider: Shulamit Kapon, University of California Berkeley

S7.2.1 Comparing the Effects of Sequencing of Physical and Virtual Manipulatives on Student Learning and Confidence

Adrian Carmichael, Kansas State University, carmichaelam@gmail.com

Jacquelyn J. Chini, Kansas State University

Elizabeth Gire, University of Memphis

N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

ABSTRACT: Previous research has shown that depending upon context, virtual manipulatives either outperform or perform equally well as physical manipulatives for promoting student learning. Here we focus on which sequence of using both manipulatives better support learning and confidence of student responses on a conceptual assessment. Our research is conducted in the context of a conceptual physics course for non-science majors at a large Midwestern university. Students completed activities in two two-hour laboratory sessions over two consecutive weeks. Some students completed the physical activity before the virtual activity, while others completed the virtual activity before the physical activity. The activities were spaced one week apart. We present the results of student performance on a conceptual test and implications for learning of different science concepts as well as students' confidence on the assessments.

S7.2.2 The Effect of Metaconceptual Teaching Activities on High School Students' Understanding of States of Matter

Zubeyde Demet Kirbulut, Middle East Technical University, kirbulut@metu.edu.tr

Omer Geban, Middle East Technical University

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ABSTRACT: The purpose of this study was to examine the effectiveness of metaconceptual teaching activities on 10th grade students' conceptual understanding of states of matter compared to traditional instruction. The experimental group consisted of 53 students, while the control group consisted of 49 students. In this study, the matching-only pretest-posttest control group design as a type of quasi-experimental design was used. To examine the effect of metaconceptual teaching activities on students' understanding of states of matter, two weeks before the treatment, States of Matter Concept Test developed by researchers was administered to students in experimental and control groups. Also, they were given at the end of the seven-week treatment period. In the experimental group, in order to facilitate students' engagement in metaconceptual knowledge and processes several types of instructional activities such as poster drawing, journal writing, group and class discussion were employed. In the control group, the same set of activities like in the experimental group such as experiments and demonstrations were used without explicit attempt to facilitate students' metaconceptual knowledge and processes. Univariate analysis of covariance results revealed that metaconceptual teaching instruction facilitated students' conceptual understanding of states of matter compared to traditional instruction with large effect size.

S7.2.3 Progressions of Students' Mental Models of Magnetism

David Sederberg, Purdue University, dsederbe@purdue.edu

Anna-Leena Latvala, University of Jyväskylä

Anssi Lindell, University of Jyväskylä

Lynn A. Bryan, Purdue University

Jouni Viiri, University of Jyväskylä

ABSTRACT: Constructing, critiquing and revising mental models require the learner to reduce a phenomenon those elements most meaningful to create a personally meaningful representation (Gilbert & Boulter, 1995). In this research, students' mental models, accessed through drawing, written explanation and interview, are used to illuminate secondary level learning trajectories for concepts of magnetism. Secondary students in Finland (N=19) engaged in a series of six lessons designed to specifically target aspects of magnetism known to challenge learners (the confusion of magnetism with charge), the organization of matter (magnetic domains), and how magnets appear to exert forces on nearby objects (magnetic fields). We describe how, with a small number of core concepts and explicitly targeted instruction, students constructed, negotiated and revised their mental models. Our findings indicate that when non-normative concepts about magnetism and magnetic interactions are repeatedly challenged in the face of evidence and reinforced, students' explanations progress toward more scientific views.

S7.2.4 Comparing Benefits of Hypertext Exploration versus Virtual Experimentation on Students' Analysis of Physical Experiments

Jacquelyn J. Chini, Kansas State University, jackiehaynicz@gmail.com

Adrian Carmichael, Kansas State University

Elizabeth Gire, University of Memphis

N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

ABSTRACT: In this study, we explore whether students who perform both physical and virtual experiments with inclined planes, but in different sequences, make the same types of interpretations of data from the physical experiment. One group of students ('Hypertext', N=67) explored the science concepts related to inclined planes using a hypertext-based concept mapping system before beginning the physical experiment. A second group ('Hypertext+Sim', N=58) used the hypertext system and performed a virtual experiment with a simulation before beginning the physical experiment. We analyzed students' responses to open-ended analysis questions answered by both groups after performing the physical experiment. We ask, do students who have a prior experience with a virtual experiment provide different interpretations of data from a physical experiment than students who have not? We find that students with the prior virtual experience focus on more scientifically useful aspects of the physical data, such as the similarity between the amounts of work needed to lift a load with different machines and between work and potential energy. However,

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students who did not have the prior virtual experience provided more scientifically correct explanations of how the length of the inclined plane affected the applied force and mechanical advantage

Strand 1: Science Learning, Understanding and Conceptual Change

S7.3 Symposium - Learning Progressions - German and Swiss Studies on Models of Competence Development

8:30am – 10:00am, Bonaire 4

Presider: Reinders Duit, IPN Kiel

Discussant: Joseph S. Krajcik, University of Michigan

Presenters:

Sascha Bernholt, IPN Kiel

Ilka Parchmann, IPN Kiel

Knut Neumann, IPN Kiel

Hans E. Fischer, University Duisburg-Essen

Andrea Möller, University of Vechta

Jürgen Mayer, University of Kassel

Susanne Metzger, Zurich University of Teacher Education

Peter Labudde, University of Applied Sciences Northwestern Switzerland

ABSTRACT: Learning progressions have gained significant attention the past years within the US science education community. The National Research Council termed learning progressions, “descriptions of increasingly sophisticated ways of understanding a topic”. In other words, learning progressions describe what it means to move over time towards more expert understanding. But the learning progression movement goes far beyond the mere attention on identifying and empirically testing efficient learning pathways. It is also fuelled by quite general attempts towards more efficient teaching and learning sequences. In a sense a framework is developing that provides orientation for attempts towards more efficient science instruction and teacher education as well. Interestingly, there are similar developments in the German speaking countries, especially in Germany and Switzerland – under the heading of “models of competence development”. It seems that the science education tradition in Germany and Switzerland as well as the more recent research activities on competence development models may contribute to the promising development in the US. Various examples for models of competence development, i.e. learning progressions, developed in Germany and Switzerland are presented. In addition it is discussed which contribution may be expected from research on models of competence development.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S7.4 Exploring Varying Approaches to Inquiry

8:30am – 10:00am, Curacao 2

Presider: Georgia W. Hodges, University of Georgia

S7.4.1 Models of Students Learning in Different Inquiry Settings Influenced by Teachers PCK

Klaara Kask, researcher, PhD, klaara.kask@ut.ee

Miia Rannikmäe, professor

Jack Holbrook, professor

ABSTRACT: This study determines student learning when teachers are guided through a teacher intervention programme to develop their PCK related to applying an open inquiry approach in their teaching. The teachers' PCK is, is categorised based on the dominant inquiry teaching approach at one of three level (A,B,C). Category A encompassing teachers identified with a dominant open inquiry teaching approach, category B teacher identified with a dominance of guided inquiry and category C, teachers only exhibiting a structured inquiry teaching approach. To characterize the students learning process, data were collected through student (N=174) pre- and post questionnaires and five standardised instructional materials created by the researcher for use in 9th grade chemistry experimental lessons.

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Results showed that the highest level of inquiry sub-skills attained by students, were associated with teachers who used a dominant open inquiry teaching approach. Based on factor analysis, the following crucial features of students' learning were extracted: inquiry orientation, motivation of students, teachers' activities, and learning outcomes. Using these characteristics, students' learning within specific classrooms was described. Models exhibiting 9th grade students' learning through open, guided and structured inquiry based experimental lessons were created. Results illustrated the essentiality of dominance on the use of open inquiry teaching.

S7.4.2 The Separation of Lab and Class in Middle School Science

Phillip M. Stewart, Teachers College, Columbia University, pms2127@columbia.edu

Ann E. Rivet, Teachers College, Columbia University

Alissa Berg, Teachers College, Columbia University

ABSTRACT: This study explores the successes and challenges of using an undergraduate laboratory model in an urban public k-8 school. We analyzed the extent and nature of the connections between teachers' intentions and students' experiences with respect to the relationship between class and lab instruction, including critical thinking and learning the scientific process through hands-on experience, through analytical use of a lab perceptions schema deduced by Russell and Weaver (2008). A key finding was that the middle school teachers were observed placing the majority of the instructional authority in the directedness of the lab manual as a means to ensure that their students arrived at an understanding of the explicit lab goal by the end of the experiment. With such strict adherence to the curriculum materials, the implicit goals of fostering critical thinking, learning the scientific process, and exploring creatively were not as strongly emphasized in this setting. However, we did observe specific glimpses of success when teachers allowed students time to explore together and when explicit connections were made between class and lab. We feel it would benefit researchers and practitioners to be aware of students' perceptions of science laboratory and how they are manifested at the middle school level.

S7.4.3 Guided Inquiry as Appropriate Instructional and Learning Method for Science Knowledge Retention in Elementary Students

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

Kristina Maruyama-Tank, University of Minnesota

Brian Fortney

ABSTRACT: This study utilizes mixed methods research design to understand the impact of guided inquiry instructional approach to teaching and learning in the retention of environment science knowledge in a third grade urban elementary classrooms. The study compared science knowledge retention between two classrooms with guided inquiry instruction (54 students) and two classroom with worksheet based direct instruction (46 students). The study shows that students who learn science through guided inquiry tend to show lower amount of learning initially compared to students who were taught science through worksheet and direct instruction. However, students in guided inquiry instruction showed greater retention of science learning over time compared to students who learned science through direct instruction. The limitations of the study are that we did not control for any science related to the content learned from outside the classroom instruction.

S7.4.4 The Effects and Moderators of Inquiry-Based Instruction in Taiwan - A Meta-Analysis

Jing-Ru Wang, National Pingtung University of Education, mail100@mail.npue.edu.tw

Sheau-Wen Lin, National Pingtung University of Education

Huey-Lien Kao, National Pingtung University of Education

Kuo-Chung Shu, Chuang Ching Elementary School

Hsin-Jung Tai, Chung Hsiao Elementary School

ABSTRACT: There is a substantial amount of literature relating learning outcomes to inquiry-based instruction in Taiwan. Yet, teaching science through inquiry is not in evidence in Taiwan. There is an urgent need for a continued effort to reexamine the effectiveness of inquiry-based instruction (IBI) by integrating empirical studies. The aims of this study were to investigate the effects of inquiry teaching on elementary and middle school student learning outcomes from the

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year 1997 to 2009 in Taiwan, as well as to explore the moderators that mediate the effectiveness of IBI on students' conceptual knowledge growth, scientific process skills and affective attitude attainments. Although the weighted mean effect size analyses attested to the greater positive benefits of IBI on students' learning outcomes compared to traditional teaching, some study features and learners' grade level were found to moderate the effects of IBI on learning outcomes. The evidence presented in this study justifies the continued use of inquiry teaching in the teaching of science.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S7.5 Symposium - Young People's Engagement in Scientific Argumentation: The Importance of Context, Curriculum, and Developmentally Appropriate Expectations

8:30am – 10:00am, Bonaire 8

Discussant: Brian J. Reiser, Northwestern University

Presenters:

Tiffany R. Lee, University of Washington, tlee13@u.washington.edu

Kari Shutt, University of Washington

Giovanna Scalone, University of Washington

Leah A. Bricker, University of Washington

Nancy Vye, University of Washington

John D. Bransford, University of Washington

Philip Bell, University of Washington

Nancy L. Salgado, University of Washington

ABSTRACT: Argumentation is recognized as a necessary and central component of science, yet it is often missing in typical science education practices. In recent years, there has been an emphasis on the need to move away from teaching science as factual knowledge and instead focus instruction around scientific discourse, explanations, and argumentation (NRC, 2007, 2009; AAAS, 1989, 1993). Not only does the emphasis on scientific discourse better align with actual disciplinary practices of professional scientists (e.g., Author, 2004; Edelson and Reiser, 2006; Newton, Driver, & Osborne, 1999), but opportunities to engage in argumentation in the science classroom have been shown to increase students' conceptual understanding and reasoning skills (e.g., Mercer, Dawes, Wegerif & Sams, 2004). Our goals for the symposium are to demonstrate how young learners engage in scientific argumentation across school and everyday settings and to argue for broader considerations for how to design learning opportunities to engage students in argumentation (cf. Authors, 2008). Specifically, we will demonstrate the need for science educators to consider the learning environments / context, curriculum, and developmentally appropriate expectations for young learners when evaluating their arguments and when designing learning opportunities.

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

S7.6 Building Scientific Explanations

8:30am – 10:00am, Curacao 3

Presider: Rogers Meredith A. Park, Indiana University

S7.6.1 Elementary Students' Enhanced Epistemic Understanding through the Appropriation of Argumentation Norms

Suna Ryu, UCLA, sunaryu@ucla.edu

ABSTRACT: The present study examines how the process of establishing norms helps students improve their epistemic understanding in a combined third- and fourth-grade science classroom. We analyze students' argument construction and evaluation tasks quantitatively and qualitatively and compared the task results to the findings of video analysis. Results show significant improvement in both citing evidence and providing justification across tasks. The practice of argumentation norms through an ongoing refinement process seemed to help improve students' epistemic understanding. We also found a clear consistency between the norms that students negotiated and refined continually and the epistemic criteria that showed improvement. While often young students are presumed not to be ready

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developmentally to provide justification, our findings support that they are capable of, but tend to fail to provide justification because they do not see it as a part of classroom culture. In our study, young students successfully justified their explanation when showing evidence and backing up your claims with reasons became their norms through ongoing negotiation. Thus, fostering argumentation norms explicitly, with the proper inquiry units could be one way to fundamentally change classroom culture, which can lead to improvement of students' ability to argue and their epistemic understanding.

S7.6.2 Explaining Explanations: Teachers' Verbal Scaffolds Associated with Three Elementary Grades Students' Building of Scientific Explanation

Nancy B. Songer, University of Michigan, songer@umich.edu

Ashima Mathur, University of Michigan

Sarah Fick, University of Michigan

ABSTRACT: What types of verbal scaffolds do teachers provide when guiding students to develop scientific explanations about focal science content? This study drew on learning progression-developed curricular units being enacted in fourth, fifth and sixth grade classrooms to characterize verbal scaffolds utilized by teachers to guide young students' development of evidence-based explanations about ecology and biodiversity. In particular, this study concentrated on the gathering and analysis of video of six cases of teachers' enactment of inquiry lessons. Two lessons from each grade level were videotaped and transcribed so that types of verbal scaffolds could be identified using an inductive approach. Findings suggest that while there are some types of verbal scaffolds that cut across all grade levels during these similar 4th, 5th and 6th inquiry-based units, other verbal scaffolds are more commonly utilized for our younger fourth graders, in association with their first experience with an learning progression-developed, explanation-building science unit. By understanding the types and range of verbal scaffolds that teachers generate, both in general and in response to varying ability audiences, we can begin to gain insights to inform both curricular design and professional development resources towards a comprehensive learning environment focused on fruitful explanation-building across time and topic.

S7.6.3 Students' Negotiation of Claims and Evidence Through Online and In-Class Discussions

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

Brian M. Hand, University of Iowa

Lori A. Norton-Meier, University of Louisville

ABSTRACT: This study aimed to examine the online asynchronous and in-class synchronous discussions and the patterns of claims and evidence produced by 5th grade students after the discussions using an argument-based inquiry approach, that is, the Science Writing Heuristic (SWH) approach. The participant students were engaged in a human health investigation using the SWH approach in their classrooms in a Midwestern public school. Data collection consisted of notes of claims and evidence posted by the students in online discussions, a video record of in-class discussions, writing samples including claims, evidence, and reflection after the online and in-class discussions. Results of this study indicate that students challenged others' evidence in terms of validity, accuracy, reliability, and sufficiency during the online and in-class discussions. In the claims and evidence produced after discussions, the students reinforced their evidence using more sets of data and more articulated evidence. It appeared that the online discussions with other 5th grade students in their school building provided them with opportunities of getting information and support for strengths and challenges on their claims and evidence. Results of this study indicated that online and in-class discussions contributed to improving students' understanding of evidence as an essential component supporting scientific claims.

S7.6.4 A Comparison of Teaching Strategies for Promoting Argumentation in Elementary Science

Elizabeth Redman, University of California, Los Angeles, elizabeth.redman@gmail.com

William A. Sandoval, University of California, Los Angeles

Noel Enyedy, University of California, Los Angeles

ABSTRACT: This paper compares the discourse strategies used by two teachers to promote argumentation in their elementary science classes. Both teachers were participants in a research project to promote scientific argumentation. Videographic observations over the course of the year showed distinct differences in the discursive moves each teacher

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made vis a vis argumentation. One teacher focused almost entirely on epistemic moves, those focused on assessing the structure and quality of particular arguments. The other teacher framed epistemic moves within dialogic moves, aimed at helping students attend to the purposes of arguing about scientific ideas and understand how to interact with each other during arguments. The students in this second class more thoroughly appropriated both dialogic and epistemic norms over the course of the year, producing more and better quality arguments over time.

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

S7.7 Knowledge and Strategies for the Life Sciences

8:30am – 10:00am, Curacao 4

President: Toth Eva Erdosne, West Virginia University

S7.7.1 Teaching About Behaviour: Beyond Choice Chambers

Jenny Lewis, CSSME, University of Leeds, j.m.lewis@education.leeds.ac.uk

Indira C. Banner, CSSME, University of Leeds

ABSTRACT: This paper reports on the development, implementation and evaluation of a teaching sequence designed to extend lower secondary school students' understanding of behaviour from a basic concept of a response to an external stimulus to a broader perspective which provides an explanatory framework for a range of biological phenomena. The sequence was developed by two teachers and a researcher working collaboratively from a social constructivist perspective. Key science concepts were identified and students' understandings of these were explored using diagnostic questions. The outcomes were used to agree the teaching goals for development of a five lesson teaching sequence designed to actively engage students in their learning. The sequence was initially implemented with 2 classes of middle ability students aged 14-15 - first to ensure that the sequence would work in the classroom, then to assess learning gains through a comparison of pre and post tests. It was then implemented by 3 teachers not involved in its development and evaluated. Despite being very positive about the approach, these teachers selected and adapted the activities for their own purposes. Students did develop a better understanding of the biological basis of behaviour but most were unable to use this to explain other biological phenomena.

S7.7.2 Mapping Out the Integration of the Components of Pedagogical Content Knowledge (PCK) for Teaching Photosynthesis and Heredity

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

Ying-Chih Chen, University of Iowa

ABSTRACT: This study explored the nature of the process by which teachers integrate different components into pedagogical content knowledge (PCK) that guides their actions in practice. Given the topic and context specificity of PCK, the investigation was conducted in the context of the photosynthesis and heredity instruction of teachers who were working at the same high school. Data sources included including classroom observations, semi-structured interviews, lesson plans, instructional materials, and students' work samples. Data were analyzed through three different approaches: (a) in-depth analysis of explicit PCK, (b) enumerative approach, and PCK rubric. Data analysis indicated four salient features of the integration of the PCK components were identified: a) the integration of the components was topic-specific, b) Knowledge of Student Understanding and Knowledge of Instructional Strategies and Representations were central in the integration, c) Knowledge of Science Curriculum and Knowledge of Assessment had limited connection with other components, and d) the coherence among the components was positively related to PCK scores. This study highlights that the quality of PCK depends more on the coherence among the components than the quality of each component. Also it demonstrates the possibility of using PCK map to make PCK more visible.

S7.7.3 A Beginning Biology Teacher's 3-Year Journey in Learning to Teach Natural Selection through Inquiry

Aaron J. Sickel, University of Missouri, ajsrhc@mail.missouri.edu

Patricia M. Friedrichsen, University of Missouri

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ABSTRACT: Despite calls from science education reform documents to teach science through inquiry, few beginning science teachers engage in inquiry teaching during their induction years. This is often due to the influence of contextual factors as teachers assimilate into unique school contexts. It is conjectured that science teachers develop knowledge for teaching specific topics throughout their careers, yet little is known about how beginning teachers develop this knowledge as they first attempt to teach topics through inquiry in their respective school environments. The purpose of this study was to investigate how a reform-oriented beginning biology teacher (Alice) developed knowledge for teaching natural selection through inquiry during induction. Using PCK and the essential features of inquiry as theoretical lenses, the researchers engaged in an interpretative case study as they observed and interviewed Alice teaching natural selection to tenth grade biology students in her first three years. Data analysis revealed that Alice's knowledge of context influenced her to become more teacher-directed in years 2 and 3. Additionally, her orientations to science teaching influenced her to provide instructional scaffolds for data collection but not for developing explanations. Implications for research on science teacher learning and for professional development to support beginning teachers are discussed.

S7.7.4 A Regional Study of the Prevalence of Biological Evolution-related Misconceptions in Secondary School Biology Teachers

Tony B. Yates, Oklahoma Baptist University, tony.yates@okbu.edu

Edmund A. Marek, University of Oklahoma

ABSTRACT: Biological evolutionary explanations pervade all biological fields and brings them together under one theoretical umbrella. Whereas the scientific community embraces the theory of biological evolution, the general public largely lacks an understanding, with many adhering to misconceptions. As teachers are functioning components of the general public and given that most teachers experience the same levels of science education as the general public, it is expected that they too will hold biological evolution misconceptions. The focus of this study is to identify biological evolution misconceptions held by secondary school biology teachers and to determine their prevalence within this teacher population. This study took place in a Midwestern state where 74 high schools served as study sites containing the study's unit of analysis: secondary school teachers who taught at least one section of Biology I during the 2010-2011 academic year. The Biological Evolution Literacy Survey Instrument (BEL) served as the research tool for identifying teacher subject biological evolution-related misconceptions and determining the prevalence of such misconceptions within the teacher subject population. The BEL contains twenty-five biological evolution-related misconception statements grouped into five categories to which teacher subjects responded by means of a Likert rating scale. Collected data and results were analyzed.

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

S7.8 Faculty & Instructor Professional Development

8:30am – 10:00am, Curacao 5

Presider: Abdulkadir Demir, Georgia State University

S7.8.1 Measuring and Replicating Science and Mathematics Faculty Perceptions of Traditional and Reformed Teaching and Learning Practices over Time

Chad Ellett, CDE Research Associates, Inc., cderesearch@att.net

Abdulkadir Demir, Georgia State University

Chad Ellett, Georgia State University

Judith Monsaas, University System of Georgia

Judy Awong-Taylor, Georgia Gwinnett College

Nancy Vandergrift, University of Georgia

Chuck Kutal, University of Georgia

ABSTRACT: This paper describes the cross sample, continuing validation of a new measure of faculty perceptions of inquiry-based, standards-based and traditional teaching and learning environments (Inventory of Teaching and Learning)

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(ITAL). The ITAL was administered to 147 science and mathematics faculty in eight IHEs using a web-based procedure in the spring of 2010. A series of Principal Components Analyses (PCAs), bivariate correlations and Alpha reliabilities was completed to examine replication of the ITAL measurement dimensions, internal validity characteristics, and freedom from measurement error. Implications of the results for future measurement and other research studies and for understanding learning environments in higher education settings are discussed.

S7.8.2 The Impact of Disciplinary Teaching and Learning Center Activities on Faculty Professional Development

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

Kathryn L. Schaefer, University of Maryland

Katerina V. Thompson, University of Maryland

ABSTRACT: This study measured the impact of a Teaching and Learning Center (TLC) in the chemical and life sciences on faculty professional development. The TLC was established in 2006 with the goal of increasing the depth, challenge and relevancy of our undergraduate curriculum and facilitating the adoption of nationally recommended teaching approaches. The TLC has catalyzed the establishment of several faculty teaching and learning communities that support curriculum redesign and adoption of innovative teaching strategies. We developed a survey to assess the impact of participation in TLC activities on (a) instructor beliefs and intentions regarding teaching, (b) perceived challenges, (c) use of innovative teaching strategies, (d) perceived level of institutional support for their efforts, and (e) perceived successes and needs. In spring 2009, 58 faculty members completed the survey. We found that since the establishment of the center, growing numbers of faculty are engaged with the national STEM education community by participating in conferences, conducting formal assessments to measure the effectiveness of their teaching innovations, and publishing their work in peer-reviewed journals. We will collect additional data in fall 2010 and fall 2012. The results presented here serve as a baseline to assess our continuing efforts to enhance faculty professional development.

S7.8.3 Defining the Readiness of High School Students to Pursue First Year University Physics

Umesh D. Ramnarain, University of Johannesburg, uramnarain@uj.ac.za

ABSTRACT: A high failure rate at first year university physics is often attributed to the lack of readiness of high school students to pursue such studies. This research explores this issue and reports on the perceptions of five physics lecturers at a South African university on the preparedness of high school students for first year physics. Qualitative data was collected through in-depth, non-directive, semi-structured interviews and analyzed for emerging themes using the AtliS.ti software. Readiness factors that were identified included the ability to engage with physics problems qualitatively rather than merely assuming an algorithmic approach, having a sound understanding of basic physics concepts, and competence in reading and speaking the scientific language. Other factors related to personal attributes and behavior and these were work ethic, perseverance, working independently and time management. These findings and their implications are discussed.

Strand 6: Science Learning in Informal Contexts

S7.9 Tell Me a Story: Using Narratives in Informal Science Education

8:30am – 10:00am, Curacao 6

President: John H. Falk, Oregon State University

S7.9.1 Pupils' Responses to Cues from the Natural World: Studies in Two cultures Using Multiple Analytic Perspectives

Sue Tunnicliffe, University of London, lady.tunnicliffe@me.com

Michael J. Reiss, University of London

Carol Boulter, University of London

Sandra Selles, Universidade Federal Fluminense, Rio de Janeiro

ABSTRACT: This paper presents an in-depth multiple analysis of the expressed understandings of natural objects of ten/eleven year-olds in a Brazilian school and pupils of the same age group in a similar English school. Eight photographs of objects in the natural world were presented to six pupils in each school in open-ended interviews. Systems theory

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was used to develop eight levels of biological organisation and applied to all interviews to show breadth of responses. the interviews were further analysed to show aspects of models and human features and influences to provide an in-depth interpretation of knowledge and experience, There are strong similarities between the case studies in the two countries such as naming parts of the objects and properties of those parts. However, the Brazilian pupils showed more frequent emotional views, more concern about endangered animals and their anthropocentric views contrast with the responses from English pupils. The findings from both countries showed that informal settings contributed substantially to the understandings of pupils.

S7.9.2 Using Stories to Scaffold Students in Science Centers

Mai Murmann, Copenhagen University, maij@experimentarium.dk

ABSTRACT: Stories or narratives have been found useful for learning and education as they enhance interest, memory and understanding and provide opportunity for reflection, evaluation, illustration, exemplification and inquiry. They also have great scaffolding properties as they provide people with a familiar structure that help shaping the construction of meaning on both an individual and a social level. This paper points out how stories can be useful for scaffolding learning activities in informal environments. It proposes a simple design tool for creating stories that take both the learning outcome and the context of the learning activity into consideration. By seeing the visit to an informal environment as an activity system with subject, object, community, rules and division of labor it is possible to create stories that support these parameters of the visit. Thereby stories should provide students with an intuitive understanding of how to act in the informal environment by helping them manage these various parameters of the learning activity.

S7.9.3 Changes in Scientific Attitudes and Beliefs by Participants in an Astronomy Citizen Science Project

Aaron Price, AAVSO/Tufts University, aaronp@aavso.org

Hee-Sun Lee, Tufts University

ABSTRACT: Citizen Science projects offer opportunities for non-scientists to take part in scientific research. We investigated changes in attitudes and beliefs about science before and during participation in an online, collaborative astronomy citizen science project called Citizen Sky. Unlike the traditional role of the volunteer to mainly collect data, this project also trained participants to make up their own hypotheses, perform data analysis, test theories and write for a professionally-reviewed astronomical journal. Two instruments measured attitudes and beliefs towards science at the beginning of their participation and again six months later. The pre-test had 1,385 responses and the post-test had 125 responses. Both instruments used a five-point Likert scale. We used a Rasch Rating Scale Model analysis to place the Likert scores on an interval scale before analyzing with standard procedures. We found mixed levels of significant changes in attitudes towards astronomy and science. The changes we did find were related to social interaction the participant has with others in the project. We also found a significant increase in beliefs in the overall nature of science, $p < .05$. Results suggest that participation in a collaborative citizen science project can positively affect attitudes and beliefs towards astronomy and science.

S7.9.4 Beyond Earth: Fostering Native Science Knowledge at Multiple Cultural/Geographical Sites in Informal Settings

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

Mark Guy, University of North Dakota

Kerry Hartman, Fort Berthold Community College

Randy Phelan, Fort Berthold Community College

Kathy Froelich, Sitting Bull College

Linda Different Cloud-Jones, Sitting Bull College

ABSTRACT: Beyond Earth- is a NSF funded planning grant designed to engage urban and rural families in science learning while piloting curriculum development and implementation that incorporates both Native and Western epistemologies. Physical, earth, and space science content is juxtaposed with indigenous culture, stories, language and epistemology in after-school programs and teacher training. Project partners include the a Science Center, two Tribal Colleges. The tribes represented in this initiative illustrate partnerships between six tribes in the midwest.

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Strand 7: Pre-service Science Teacher Education

S7.10 Preservice Teacher Self Efficacy

8:30am – 10:00am, Curacao 7

S7.10.1 Preservice Teachers' Sentiments, Attitudes, Concerns and Self-Efficacy about Inclusive Education: Validation of SACIE Scale

Mustafa Cansiz, Artvin Coruh University, mustafacansiz@gmail.com

Nurcan Turker, Ataturk University

ABSTRACT: This paper portrays the validation of Sentiments Attitudes and Concerns about Inclusive Education Scale (SACIE) which measures sentiments, attitudes and concerns about inclusive education in preservice teachers based on an examination of the data gathered from 304 preservice teachers from two different universities. Based on principal component analysis, the validation of the instrument is satisfied with three factors. Additionally the relation between preservice teachers' sense of self-efficacy and their sentiments, attitudes and concerns about inclusive education is investigated.

S7.10.2 How Would they Know? Developing Elementary Preservice Teachers

Tina J. Cartwright, Marshall University, johnson516@marshall.edu

Suzi Smith, Marshall University

ABSTRACT: The purpose of this study was to compare changes in self-efficacy, particularly their outcome expectancy, across two groups of elementary preservice teachers: one group from a traditional methods course with just one teaching experience and one group who taught 45 hours of after-school science lessons. Multiple challenges exist in evaluating the teaching efficacy of elementary preservice teachers including conceptualizing teaching efficacy, as a construct itself and also by preservice teachers who have yet to actually teach science. This study provides the opportunity to compare the conceptualization of teaching efficacy across two groups of preservice teachers at multiple testing administrations including a retrospective pretest. Along with traditional pretest and posttest, a retrospective pretest was utilized to assess changes in self-efficacy and outcome expectancy across both groups. Results suggest that participating in the after-school teaching experience resulted in the experimental group lowering their retrospective STOE, which implies that their lengthy interaction with students teaching real science lessons resulted in their reevaluation of their ability to shape students' science learning. This study utilizes alternative ways to assess preservice teachers' efficacies and demonstrates how alternative methods courses which utilizing alternative after-school field experiences can lead to more effective teachers of science.

S7.10.3 Correlates of Elementary Preservice Teachers' Science Teaching Efficacy Beliefs

Pamela Cantrell, Brigham Young University, pamela_cantrell@byu.edu

James A. Cantrell, Utah Valley University

Michael R. Patch, Utah Valley University

ABSTRACT: Potential relationships among elementary pre-service teachers' science teaching efficacy beliefs, learning context preferences, actual learning contexts, level of adulthood, and instructor teaching philosophies were examined. Junior and senior students enrolled in science methods courses from two universities (n = 206) were surveyed for indicators of level of adulthood and learning context preferences. They were also administered the Science Teaching Efficacy Beliefs Instrument using retrospective pre-test methodology. Instructors (n = 6) were surveyed to reveal their preferred teaching philosophy from among five philosophies based on the tenets of adult education theory. Results indicate there may be a disconnect between students' preferred learning context and instructors' teaching philosophies. Students were best able to identify classroom contexts where instructors scored higher on the liberal (traditional teaching) philosophy scale, which was also the only teaching philosophy that was positively related to science teaching efficacy beliefs. No relationship was found between science teaching efficacy beliefs and level of adulthood.

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Strand 7: Pre-service Science Teacher Education

S7.11 Topics in Science, Technology, Society, and the Environment

8:30am – 10:00am, Bonaire 7

Presider: Deborah J. Corrigan, Monash University

S7.11.1 Impact of an STS-Oriented Methods Course on Prospective Teachers' Level of Environmental Literacy

Aidin Amirshokoohi, Fairfield University, aamirshokoohi@fairfield.edu

ABSTRACT: The Science, Technology, and Society (STS) effort, promoting the teaching of science in a social context, is an important path in achieving scientific and technological literacy. A number of STS issues have direct environmental consequences and environmental education (EE) has been termed as synonymous to STS education. Social-civic literacy, a key component of STS curriculum, is similar to the environmental literacy goal of EE. The current study, utilizing a triangulation mixed method design, investigated the impact of an STS oriented instruction on pre-service elementary teachers' level of environmental literacy. Two sections of a regular science methods course were compared to two sections that had an STS focus. The pre and post Environmental Literacy Instrument (ELI) data analyzed by inferential statistical procedures revealed: 1) the treatment group had significantly higher post-test total and seven subsection means than those of the comparison group and 2) the treatment group's post-test total and seven subsection means were significantly higher than its pre-test means. The pre and post interview data analyzed through an analytic induction method corroborated the quantitative results. This study would be valuable to science educators who ultimately bear the responsibility of preparing pre-service teachers to employ an STS-based instructional approach.

S7.11.2 An Exploration of Preservice Science Teachers' Written Argumentation about the Global Climate Change Issue

Dilek Karisan, Yuzuncu Yil University, dilekkarisan@gmail.com

Mustafa S. Topcu, Yuzuncu Yil University

ABSTRACT: The aim of the present study is two fold. First, we examined the nature of the written argumentation of Preservice Science Teachers (PSTs). Second, we explored the development of PSTs' written argumentation during the course instruction. The participants of the study were twenty PSTs (70 % female) from the Department of Elementary Science Teacher education at a large University in Turkey. The course instruction was based on argumentation theory and writing. The instruction were continued in the science method course, which is a required course in the elementary science teacher education programme in Turkey, and lasted for 9 weeks. During the instruction, PSTs wrote scientific argumentation papers for each selected global climate change topics (the melting of polar ice, drought & water shortage, natural disasters & migrations, and the effects of climate change on living organisms). These papers were used as data source to examine PSTs' nature of written argumentation. The results indicated that PSTs can easily for plausible and supportable claims and they can also pose solvable and researchable thesis statements. However, they lack to develop multiple lines of reasoning skills, and to describe complex mechanisms. Overall, the results indicated that PSTs' written argumentation tends to improve with argumentation writing experiences

S7.11.3 Using Citizen Science as a Framework for Teaching Pre-Service Secondary Science Teachers: How does Understanding Emerge?

Stacey A. Britton, University of Georgia, biolady24@yahoo.com

Deborah J. Tippins, University of Georgia

Melissa Freeman, University of Georgia

ABSTRACT: Teacher preparation currently provides an avenue for introducing new techniques that will re-focus our concerns, place value in local, community knowledge and make students accountable and aware of their decisions. This presentation will illuminate citizen science as an alternative framework for science teacher preparation and promote the use of ethnographic methods in science education research. Rich descriptions of events and unfolding ideas will help frame the discussion around citizen science and highlight the structure it provided for a pre-service science teacher methods course.

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S7.11.4 Case Studies: Addressing Socioscientific Issues in a Teacher Education Course

Isha Decoito, York University, IDeCoito@edu.yorku.ca

Maurice Diguiseppe, University of Ontario Institute of Technology

ABSTRACT: Despite the growing corpus of research on SSI in science education, the relevant implications for science teacher education remain relatively unexplored. There is a need for pre- and in-service programs that challenge teachers' discomfort and suggest means for teaching controversial issues. In order to better inform these efforts, it is necessary to learn more about how pre-service teachers use science curriculum materials dealing with SSI in science learning environments. With the goal of gaining a better understanding of how to support teacher candidates in fostering their future students' understanding of SSI, this research study took place in a science curriculum methods class whereby teacher candidates were supported by the instructor in the development of case studies about SSI. Through the development of case studies, the research study explored teacher candidates' (1) knowledge and understanding of SSI, (2) beliefs about teaching SSI in the science classroom, and (3) knowledge of effective instruction and assessment practices that address STSE expectations in the science curriculum. Findings indicate that teacher candidates possessed varying understandings of SSI, some well informed, others naïve. Additionally they held strong beliefs when it came to teaching about SSI, citing their frustrations including time constraints, limited resources, and student resistance.

Strand 8: In-service Science Teacher Education

S7.12 Related Paper Set - Professional Development Models to Support Teachers to Teach Nature of Science and Inquiry

8:30am – 10:00am, Curacao 8

Presider: Anil C. Banerjee, Columbus State University

ABSTRACT: This related paper set presents four different models to support science teachers to teach nature of science and inquiry. The framework of the models is based on inquiry as envisioned in the national science education standards. Project ICAN (Inquiry, Context, and Nature of Science) was a five-year NSF Teacher Enhancement grant that focused on the development and implementation of a professional development model to enhance middle and high school science teachers' disciplinary and pedagogical knowledge related to unifying concepts, scientific inquiry, and nature of science. Project Guided Inquiry is a three year Teacher Quality grant on a professional development model to teach chemistry using guided inquiry. The model provides intensive support to teachers to develop and field-test guided inquiry laboratory experiments, integrate with the curricula, and then teach using inquiry. Student-Teacher-Scientist-Partnerships (STSPs) are partnerships in which students, teachers, and scientists work together to answer real-world questions about a phenomenon or problem the scientists are studying, and often focus on scientific research that could be enhanced by K-12 student participation. 'Engaging teachers in authentic science research' examines effective components of professional development programs that engage teachers in authentic science research and facilitate the transfer of those experiences into classroom practice.

S7.12.1 Project ICAN: A Program to Enhance Teachers and Students' Understandings of Nature of Science and Scientific Inquiry

Norman Lederman, Illinois Institute of Technology

Judity Lederman, Illinois Institute of Technology

S7.12.2 Project Guided Inquiry: Effect of Guided Inquiry and Traditional Instruction on Student Understanding of Chemistry Concepts and Science as Inquiry in High Schools

Anil C. Banerjee, Columbus State University

S7.12.3 Teacher Professional Development through Student-Teacher-Scientist Partnerships

Ana Houseal, University of Illinois at Urbana Champaign

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

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S7.12.4 Engaging Teachers in Authentic Science Research: What Impacts Classroom Practice?

Renee' Schwartz, Western Michigan University

Strand 9: Reflective Practice

S7.13 Teacher Learning through Reflection

8:30am – 10:00am, Bonaire 6

Presenter: Tamara Holmlund Nelson, Washington State University Vancouver

S7.13.1 How does Reflection on Inquiry and Practice-teaching Result in Changes in Teacher Pedagogical Theories?

Ralph E. Spraker, South University, rspraker@southuniversity.edu

Christine Lotter, University of South Carolina

Gregory R. Rushton, Kennesaw State University

ABSTRACT: This study used multiple sources of data to analyze how in-service high school chemistry teachers' reflection about inquiry and inquiry enactments during a professional development influenced their pedagogical beliefs. Using multiple case study methodology, we collected in-depth data on participants' beliefs and practice including participant-observation in their classrooms. Specifically, we answered the following question: How does reflection on the inquiry approach and practice teaching result in changes in these teachers' pedagogical theories? Reflection data from the participating teachers showed they believed that modeled inquiry placing them in the student-learner role helped them to re-examine their pedagogical theories. The teachers also emphasized the role that practice teaching and immediate reflection had on their pedagogical growth. The teachers also described the importance of a professional learning community on their use of inquiry-based instruction. The data also showed that the participating teacher's understanding of reflection had changed from a static to a more dynamic conception by the end of the professional development. This study has implications for in-service professional development design.

S7.13.2 Teachers' Perspectives of Professional Learning Communities in the Schools

Sarah W. Robert, North Carolina State University, sarahwrobert@gmail.com

M. Gail Jones, North Carolina State University

Laura E. Robertson, North Carolina State University

ABSTRACT: As part of ongoing school reform, there is a goal of promoting teacher professional development. "Developing professional learning communities appears to hold considerable promise for capacity building for sustainable improvement (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006)." The staff of the school are the means through which improvement can happen (Bezzina & Testa, 2005). True communities assume a shared purpose, mutual respect, and honesty and truthfulness (Hord, Winter 2009). There is growing evidence in the literature that professional learning communities (PLCs) are an effective way to impact change and improvement in student learning (Bezzina & Testa, 2005; Dooner, MAndzuk, & Clifton, 2008; Dufour, 1999; Hipp, Huffman, Pankake, & Oliver, 2008; Hord, Winter 2009; Lieberman & Miller, 2008; Stoll, et al., 2006) This study focuses on teachers' perspectives of the efficacy of the PLCs in place in their schools. The teachers' perspective of the impact, usefulness, and effectiveness of the PLC in their school can make or break the PLC (Maudry & Stiles, 2009). Of interest here is whether teachers' perspectives change depending on teachers' level of experience and/or grade level taught. Does the perception of the purpose of the PLC impact it's perceived success?

S7.13.3 Developing Preservice Science Teachers in Video-Centered Communities of Practice

Ron Tinsley, Richard Stockton College of New Jersey, ron.tinsley@stockton.edu

Kimberly Lebak, Richard Stockton College of New Jersey

ABSTRACT: In this presentation, we explore the use of video-centered communities of practice (VCCOP) as a catalyst for the development of reflective capacity in preservice elementary science teachers. Through VCCOP, preservice teachers engage in a cycle of collaboratively planning lessons, teaching the lessons to each other, viewing and reflecting on videos of their teaching, and then writing individual reflection papers. We report on the collaborative reflections of one VCCOP

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of seven preservice elementary science teachers as they viewed and discussed videos of their teaching demonstrations. Findings indicate that the use of VCCOP with preservice teachers can promote reflective capacity and support the development of reflective practice, especially in reflecting on instructional techniques. Furthermore, we detected emergent PCK resulting from the process. In a VCCOP collaborative reflection moves quickly beyond surface level going deeper into instruction and content; the formation of PCK occurs organically in a shared context.

S7.13.4 Helping Preservice Teachers Find Meaningful Engagement in Scientific Inquiry: A Self-study of Relational Teacher Education

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

Gayle A. Buck, Indiana University Bloomington

Nicole Beeman-Cadwallader, Indiana University Bloomington

ABSTRACT: This self-study documents the extent to which I was able to provide preservice teachers with relevant and meaningful opportunities to talk and act like scientists in ways that cohered with personal experience. In particular, I explored my enactment of relational pedagogy that served to engage students in inclusive scientific discourse and practice. Relational pedagogy was used to promote students' active engagement in: (1) personal construction of scientific inquiry knowledge and skills; (2) sharing authority over the direction and focus of their own science learning; and (3) realizing themselves as agents of science. Findings indicate that students developed scientific knowledge and skills through engagement in inquiry grounded in problem/questions they found meaningful. Giving students space to explore and discuss the nature of science fostered a substantial change in their ideas about scientific inquiry. Verbal and written feedback processes afforded students with opportunities to question science and act as agents in learning. And although I was able to open up classroom discourse in productive and supportive ways, doing so required constant personal reflection on the role of teacher and student in the classroom. This study is useful to those seeking to create a more egalitarian science classroom in preservice teacher education.

Strand 10: Curriculum, Evaluation, and Assessment

S7.14 Selecting Evolution

8:30am – 10:00am, Bonaire 1

Presider: Mehmet Aydeniz, The University of Tennessee

S7.14.1 Comparative Efficacy of Two Computer-Assisted Scoring Tools for Evolution Assessment

Minsu Ha, The Ohio State University, ha.101@osu.edu

Ross H. Nehm, The Ohio State University

ABSTRACT: The growing use of computer assisted scoring (CAS) in many academic disciplines is driven by the numerous disadvantages that characterize human scoring of constructed response items; these include high costs (in terms of scoring time and expert training) and delayed feedback to test takers. Furthermore, human scoring is problematic because of grading fatigue, inconsistent training and/or background knowledge of graders, and the intrinsic subjectivity associated with interpretation. The persistent question asked of CAS systems is whether they can measure written responses as accurately as human scorers. In line with this question, our study compares the efficacy of two CAS tools (SIDE and SPSSTA) for measuring student knowledge of a core idea in the biological sciences: natural selection. Methodologically, we use Cohen's Kappa to quantify levels of agreement between CAS scores and human expert raters; Kappa statistics compensate for chance inter-rater agreements. We employ a dataset of 1572 open-responses from a previously published instrument. Our results indicate that both SIDE and SPSSTA approximate human-human agreement levels (Kappas > 0.7) and are effective tools for scoring evolution essays. Nevertheless, the machine learning approach used in SIDE requires significantly less programming, set up time, and content expertise than SPSSTA.

S7.14.2 Design and Research of an Evolution and Medicine High School Curriculum Intervention

Paul M. Beardsley, BSCS, pbeardsley@bscs.org

Molly A.M. Stuhlsatz, BSCS

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Mark Bloom, BSCS
Anne L. Westbrook, BSCS
Rebecca A. Kruse, BSCS

ABSTRACT: The purpose of this study was to develop and explore the impact of a two-week high school curriculum intervention for teaching about evolution with medical examples. The intervention, developed with an Understanding by Design approach, used an instructional model based on constructivist learning theory and included inquiry-based pedagogy. Field test data from design research and evaluation on a nationwide field test included student and teacher evaluations of the materials and student pre/post knowledge tests. Teacher surveys suggested the intervention was effective (mean 5.0 out of 6) and students rated the difficulty of lessons between “Just about Right” and “Difficult.” High school students across the U.S. showed low levels of understanding of evolution on the pretest. Initial evaluation of student scores from pretest to posttest showed significant gains for all groups with a relatively high effect size (0.7). A preliminary analysis of differences between groups revealed no significant differences for gender, but there were significant differences between students who do and do not receive free or reduced lunch and grade level. After controlling for pretest scores, other analyses indicate that there is no significant difference between white students and all other racial/ethnic categories ($B = -.051$, $p = .325$).

S7.14.3 A Conceptual Analysis of the Conceptual Inventory of Natural Selection: Improving Diagnostic Utility through within Item Analysis

Erin Marie Furtak, University of Colorado at Boulder, erin.furtak@colorado.edu
Deborah L. Morrison, University of Colorado at Boulder
Heidi Iverson, University of Colorado at Boulder
Michael J. Ross, University of Colorado at Boulder

ABSTRACT: Anderson, Fisher & Norman's (2002) Conceptual Inventory of Natural Selection (CINS) is the major published conceptual assessment of student understanding of evolution. The purpose of the CINS is to provide diagnostic information to instructors so that students' particular misunderstandings of the concept may be identified and acted upon. We argue that although the CINS was constructed to entail unidimensional items linked to Mayr's (2001) facts and inferences, the majority of the items are actually multidimensional, making difficult the diagnosis of particular student ideas. In order to improve the quality of the CINS as a diagnostic assessment, this paper will present a conceptual analysis of the items on the CINS and will propose revised distractor driven multiple choice items. We present our own conceptual representation of the domain of natural selection, and then demonstrate how each CINS item (and its distractors) may be mapped onto this representation. Then, we will illustrate how we have revised the original CINS items into unidimensional items. The paper will contribute a version of the CINS with increased diagnostic utility to the field of biology education.

S7.14.4 Assessing Middle and High School Students' Understanding of Evolution with Standards-based Items

Jean C. Flanagan, AAAS Project 2061, jflanaga@aaas.org
Jo Ellen Roseman, AAAS Project 2061

ABSTRACT: Understanding evolution is key to becoming an informed, science-literate citizen, as it is the basis for understanding all of modern biology and is involved in environmental and health policy issues. Much research has shown, however, that most students lack a correct understanding. While some assessment tools have been developed, none have been tested on a large scale. A standards-based multiple choice assessment of evolution concepts was developed and field tested on 9,419 middle and high school students in 43 states across a broad range of demographics. Common misconceptions were used as the distractors wherever possible. Four key ideas were assessed: similarities and differences between species, the changing environment, the mechanism of natural selection, and the common ancestry of life. The overall mean percent correct was 42.3%. High school students (48.1% correct) performed significantly better than middle school students (38.9%). For all students, the idea of common ancestry was significantly harder than the other three ideas. We noted that a subset of the items aligned to this idea, which dealt with common ancestry in apparently similar and apparently different organisms, were especially difficult for students. The misconception that distantly related organisms share no similarities was found to be strong among all students.

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Strand 11: Cultural, Social, and Gender Issues

S7.15 Persistence and Success in the STEM Pipeline

8:30am – 10:00am, Bonaire 2

Presider: Gillian U. Bayne, Lehman College of the City University of New York

S7.15.1 Evaluating an Intervention to Support Undergraduate Women in STEM Majors

Barbara A. Burke, California State Polytechnic University, Pomona, baburke@csupomona.edu

Dennis W. Sunal, University of Alabama, Tuscaloosa

Cynthia V. Sunal, University of Alabama, Tuscaloosa

ABSTRACT: This paper reports a study of an undergraduate intervention model aimed at increasing upper division women's graduation rate in physics, chemistry, mathematics, and computer science at a Hispanic Serving Institution (HSI). This model provides a framework for support that includes mentoring, research, supportive networking, and developing a personal professional identity. Based on the results of this study, factors are identified that are associated with sustaining academic progress for 97% of women participants in the targeted STEM majors. Findings are based on data gathered via individual and focus group interviews and analysis of student and faculty materials and artifacts. Results include positive findings in the areas of: providing students with research experiences in meaningful and real life problem situations; building long term deep student and faculty interactions; expanding students' perceptions of the discipline and career; improving students' confidence; providing time for professional socialization; providing experiences in professional presentations and writing; and creating a learning community of peers. The factors provide a supportive model that can be tested and used to advance the success of undergraduate women, as well as other underrepresented groups, at this and at other similar institutions serving diverse student populations.

S7.15.2 The Current Influences on Women's Persistence in STEM fields at the Undergraduate Level

Roxanne Hughes, Florida State University/National High Magnetic Field Laboratory, hughes@magnet.fsu.edu

ABSTRACT: Women represent less than a third of undergraduate and graduate degrees in science, technology, engineering, and mathematics (NSF, 2007). Past research has hinted at a number of predictors for women's success (e.g. Eccles, 2007). However, my recent study highlights how these predictors do not paint the full picture. In reality, each woman has a unique set of experiences that leads to her eventual decision to stay or leave STEM fields (Butler, 1997; Eccles, 2007). This paper presents the results of a series of narrative life history interviews with female seniors in college, half of whom chose to stay in their original STEM field and half left. The results indicate that women's persistence in STEM fields is related to successes in math and science classes; support from parents and teachers/professors; and a peer support network at the college level. The results of this study can help college STEM programs improve their persistence rates, especially for the underrepresented female students.

S7.15.3 STEM Graduate Students' Multiple Identities: How Can I Be Me and Be a Scientist?

Josephine A. Gasiewski, Post-doctoral Research Fellow, UCLA, joski@ucla.edu

Minh C. Tran, UCLA

Felisha Herrera, UCLA

ABSTRACT: While there is an ever increasing push in the U.S. for STEM education, there is a concurrent call for increasing the diversity of the student body. Traditional norms dictating scientific teaching, learning, and practice can promote dominant groups while marginalizing minority identities. As we seek to expand STEM education and degree attainment, it is critical to understand how students come to view themselves as scientists. Data are drawn from over 60 hours of focus group interviews with 150 graduate students from seven universities across the U.S. Preliminary findings reveal that students engage in a constant negotiation process in order to successfully merge their identities as scientists with their racial, gender, SES, religious, and sexual identities and to achieve and persist in STEM fields. Identity intersections were revealed in: initial motivations for entering STEM fields, desire to increase representation in the professoriate, perceptions of lower expectations based on race/gender, conflict with dominant science culture, religion versus scientific objectivity, conveying science to non-scientists, and glass ceiling/family planning pressures based on

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gender. Findings from this study contribute to a better understanding of STEM students' identity formation, the internal and external factors at play, and what STEM graduate education looks like for students from diverse backgrounds.

S7.15.4 A Survey of the Scientific Epistemological Views of College Students: Assessing the Impact of an Implicit Curriculum in Science Education

Leigh S. Arino De La Rubia, Tennessee State University Nashville, leigh.arinodelarubia@gmail.com

John Mark Hunter, Tennessee State University Nashville

ABSTRACT: Research into the Scientific Epistemological Views (SEVs) of STEM Majors at an HBCU has recently been undertaken to determine the extent that student SEV is a factor in undergraduate students' experiences. This research has helped illuminate trends in college student SEV according to various demographic indicators in order to properly assess the role epistemology may play in the retention of students in STEM majors who come from under-represented groups.

Strand 12: Educational Technology

S7.16 Modeling and Video Tools in Science Education

8:30am – 10:00am, Bonaire 3

President: Jacqueline McLaughlin, The Pennsylvania State University

S7.16.1 A Study of Modeling-based Teaching with Computer Simulation Inquiry

Jen-Chin Lin, National Kaohsiung Normal University, Taiwan, jclin@nknuc.nknu.edu.tw

Jeng-Fung Hung, National Kaohsiung Normal University, Taiwan

ABSTRACT: In this research, the researcher proposed MCSI(modeling-based computer simulation inquiry) mode to compare the learning effectiveness between the different teaching modes of science. The isPM, a computer software developed by the researcher, was used in this research to enable students to do the pendulum's empirical experiment. A quasi-experimental design was used and the participants of this research were junior high school students (in ninth grade). There were two groups, including 25 students taught with MCSI teaching mode in one group, and 25 students taught with the mode of general inquiry in another one. The learning effectiveness was evaluated with the investigation composed of 4 domains, including the control of variables, the concept of period, the line graph which was based on the result of experiment, and the application of models. The results of this research indicated that there was no significance between the two groups in the learning effectiveness in terms of the control of variables aspect. In the concept of period aspect there was significant difference among the two groups but the Partial Eta Squared was lower. However, the performance of the group taught with MCSI mode was obviously better than the other one in line graphs drawing and the application of models. Moreover, the researcher further analyzed the teaching process of MCSI mode to draw a learning pathway, including students' model competition as well as teacher's guidance in the stage of explanation and interaction. Finally, this research modified the MCSI teaching mode so as to improve the science learning effectiveness.

S7.16.2 I Just Want to Make It Work: Examining Students' Programming Actions Impeding Productive Model-based Inquiry

Lin Xiang, School of Education, University of California, Davis, lxiang@ucdavis.edu

Cynthia Passmore, School of Education, University of California, Davis

ABSTRACT: This study seeks to gain a deep insight into a programming-supported model-based inquiry process. In this study eight 8th grade students worked collaboratively to explore natural selection model by programming a simulation of adaptation. Videotape of students' programming processes and group discussion are used as primary data to identify student activity and conversation patterns. In this paper we particularly present our findings about three student actions that may relate to the difficulties students face in conducting productive programming-supported model-based inquiry: phenomenon-orientated programming, transplanting program codes, and blindly running simulation. We claim that while conducting these actions students did not make connection between target phenomena and underlying model.

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Our findings imply that educators should design proper learning tasks or activities to avoid these actions when using programmable modeling tools to support model-based inquiry.

S7.16.3 Practicality in Virtuality: Finding Student Meaning in Video Game Education.

Timothy M. Barko, University of Florida, tim.barko@ufl.edu

Troy D. Sadler, University of Florida

ABSTRACT: This study uses pre-post data collected during a summer science program in order to delineate trends in the computer-based game learning environment Mission Biotech, a biotechnology themed game designed to promote student-based learning through a virtual laboratory experience. The nature of “virtual” versus “real” practical knowledge is discussed with the intention to facilitate the understanding of how these students’ experiences with Mission Biotech impacted their knowledge of both generic biotechnology and practical content. Due to limited sample sizes, a nonparametric Wilcoxon signed-rank test was used to compare the significance of the full range of pre-post content with that of practical knowledge gains associated with Polymerase Chain Reaction (PCR), laboratory technology showcased within Mission Biotech. It was determined the pre-post gains from the within-test PCR items were significant whereas the gains from the full range of content items were not. The implications of these findings for the future of computer-based game development and learning are discussed in the context of “communities of practice” and their affect on practical knowledge gains.

S7.16.4 Investigating the Role of Video to Support Student Understanding of the Nature of Scientific Work

Kasey McCall, University of Michigan, kaseyl@umich.edu

Leeann M. Sutherland, University of Michigan

Namsoo Shin, University of Michigan

ABSTRACT: National science standards call for students to participate in inquiry settings that expose them to authentic learning environments where they participate in scientific practices. Though national standards call for students to learn science content and practices, classroom instruction often presents science as a body of factual knowledge. Classroom teachers often struggle to develop authentic science settings for students that support their understanding of the nature of scientific work. This paper examines the use of video technology as a means to explicitly exposing middle school students to two specific scientific practices, the use of evidence and models, to explain scientific phenomena. This paper will report the video design, patterns in student viewing behaviors, and examine the potential of video to support student understanding of key aspects of the nature of science and scientific practices as they learn from peer mentors.

Strand 14: Environmental Education

S7.17 Sociocultural Perspectives in Environmental Education

8:30am – 10:00am, Bonaire 5

Presenter: Heather Toomey Zimmerman, Pennsylvania State University

S7.17.1 Using Informal Reasoning to Consider Trade-offs and Resolve Dilemmas

Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu

Alison M. Wallace, Minnesota State University Moorhead

Steve Dahlberg, White Earth Tribal and Community College

ABSTRACT: The objective of this study was to examine how Native and non-Native American college students write about dilemmas and the possible solutions to resolve these dilemmas using informal reasoning. Specifically, we asked 1) what types of dilemmas and solutions did the two populations identify, and 2) did the emergent patterns in their responses reflect students’ respective cultures. Students used reading-to-learn and writing-to-learn activities while studying about fertilizer run-off in the Midwest and its association with Dead Zones in the Gulf of Mexico. We found that Native students most often considered trade-offs that were centered on environmental concerns; whereas, non-Native students considered trade-offs that were economic centered. We argue that the findings represent students’ cultural worldviews. The implications of this activity are that writing activities allow students to use their own funds of cultural

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knowledge and informal reasoning, along with scientific knowledge learned in class, to develop their personal positions and decisions about how to resolve dilemmas.

S7.17.2 Same Curriculum - Different Cultures: Same Knowledge and Attitudes Concerning Socio-scientific Issues?

Aviva Klieger, Beit Berl Academic College, aviva@yavin-yeda.com

Tili Wagner, Beit Berl Academic College

Alon Fragman, Beit Berl Academic College

ABSTRACT: Socio-scientific issues (SSI) play a significant role in decision making for citizens in the 21st century and thus should be listed as one of the major goals of science education. The current study examines whether high school students from two different sectors studying the same science curriculum hold the same knowledge, attitudes and environmental behavior in the context of SSI (e.g., global warming, energy and water crisis). We used a qualitative methodology. We interviewed 12 students from both sectors. Content analysis of the interviews was conducted. The findings indicate that information sources about SSI of students from both sectors are media and not school. Their knowledge on SSI is lacking and most students do not understand the causes of the problems. Very few view the problems from a global perspective. Students from one sector regard the local councils and not themselves as responsible for solving the problems, while students from the other sector are more active and exhibit greater willingness for involvement on the personal level. In order to raise awareness on a global level and enhance activism on a personal level, the school science curriculum should integrate more SSI and refer to the different cultures of the students.

S7.17.3 A Sociocultural Investigation of the Goals for the Environmental Science Course: Teacher and Student Perspectives

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

ABSTRACT In recent years, the Environmental Science course has become increasingly integrated into the high school curriculum (Edelson, 2007). However, there has been little research into the guiding objectives that teachers are using as the basis for their curriculum. Using a sociocultural approach that allows for exploration of socioeconomic factors, social interactions, and cultural norms, this study investigates the goals established by one Environmental Science teacher and the reaction of her students to these goals as they are enacted in the classroom. Through qualitative methodologies including participant observation, formal interviews, videotape, and cogenerative dialogues, the data reveals the teacher's reasoning for establishing the various goals for the course, as well as the students' perspective on how they perceive these goals affecting them and their learning. The various goals explored in this research include the role of science content knowledge and critical thinking; developing students' emotional connection with environmental issues; and empowering students' to feel that they can make a difference through their own actions. The findings from this research inform the greater science education community regarding some of the issues facing Environmental Science teachers as they work to provide our students with an education regarding many key issues affecting our environment.

Strand 15: Policy

S7.18 Standards and Accountability for Science Teaching

8:30am – 10:00am, Antigua 2

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

S7.18.1 Science Standard Specificity and the Increasing Targets of Formative Assessments in High School Chemistry

Carlos C. Ayala, Sonoma State University, carlos.ayala@sonoma.edu

Andrea Chase, Sonoma State University

ABSTRACT: Formative use of diagnostic classroom assessment is a powerful way to improve student achievement. However, when designing these assessments the selection of the targets becomes a complicated matter. A challenge arises in the selection process because of the conflicting sources of learning targets that range from national standards, state and local standards, textbooks, and to teacher's pedagogical repertoires. While the national standards provide

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broad conceptual targets, the specific details needed to inform teaching, curriculum development and assessing are left to the implementers. Selection of formative assessments targets further expands these targets because students who do not have the necessary prerequisite knowledge may not benefit from a formative assessment system if their current state of knowledge does not allow them to participate in a meaningful way in the formative assessment system. This creates a surge of instructional and assessment targets. In this paper we present our analysis of the scope of the national science standards and compare these to state science standards and textbooks. We use this analysis to argue for a coherent rationale for what should be included in high school chemistry formative assessments and present our NSF DRK-12 Chemistry formative assessments and targets with respect to the atomic nature of matter and changes in matter.

S7.18.2 The Scientific Theory of... Lessons Learned from Florida's 2008 Science Standards Adoption

Lance E. King, Florida State University, king@bio.fsu.edu

Sherry A. Southerland, Florida State University

ABSTRACT: Efforts on the part of the Common-Core Standards Initiative (CCSI) to develop Next Generation K-12 Science Standards for the vast majority of U.S. public school students are currently well-underway. Florida's experiences in the framing, writing, and adoption of their Next Generation Science Standards (NGSSS) in 2008 can provide a preview of the conflicts that will likely emerge at a national level when the Common-Core Science Standards are submitted to the state Boards of Education of the forty-eight states that have committed to their adoption. Florida's experiences in employing nature of science principles in forging a consensus around the contentious topic of evolution can be of great benefit to the CCSI as they develop these standards, as well as informing stakeholders who will be called upon to review the drafts that emerge from this process.

S7.18.3 The Accountability Variable: Science Achievement and Differing Methods of Accountability in the United States

Eugene Judson, Eugene.Judson@asu.edu

ABSTRACT: Though it is a requirement of NCLB for science to be assessed in at least three grades, the achievement results from those science exams are not required to be used when calculating Adequate Yearly Progress (AYP). Whether or not a school "makes" or "misses" AYP over successive years is a critical determinant of whether or not a school is subject to state department sanctions. Additionally, some states have developed their own dual accountability programs alongside of AYP that include science achievement results. In this study fourth- and eighth-grade NAEP science achievement data were analyzed to determine if there were detectable differences in results between states that do and do not integrate science into school accountability formulas.

PL2 Plenary Session #2

Human Identity & Environmental Challenges

10:30am – 12:00pm, Grand Sierra E

President: J. Randy McGinnis, University of Maryland

Keynote Presenter: Tim Kasser, Knox College

ABSTRACT: Despite some important successes, the efforts of the environmental movement have thus far failed to activate the kinds of personal and social changes necessary to meet the many ecological challenges we face. A growing body of psychological research suggests that if these efforts incorporated more knowledge about human identity (including our values, our sense of social identity, and the ways we cope when threatened), greater progress toward a more sustainable world might be forthcoming. This keynote will focus primarily on research documenting how the strong priority placed on extrinsic, materialistic values (for money, image, and status) can undermine pro-environmental attitudes and behaviors. Strategies science educators could utilize to promote sustainability via attention to this particular aspect of human identity will be addressed.

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Equity and Ethics Sponsored Session

S8.1 Symposium - Thinking Globally, Acting Locally -- Initiatives to Improve Science Learning for All

2:15pm – 3:45pm, Antigua 1

Presider: Sumi Hagiwara, Montclair State University

Presenters:

Nirmala Ramlakhan, University of Central Florida

Mika Munakata, Montclair State University

Ken Wolff, Montclair State University

Mary Lou West, Montclair State University

Judith Lombana, Museum of Science and Industry, Tampa, Florida

Doris Ash, University of California, Santa Cruz

Jrene Rahm, Universes de Montreal

ABSTRACT: In this Equity and Ethics Committee-sponsored symposium, three groups of educators share their efforts to enhance and improve the experiences of underrepresented students in science. Nirmala Ramlakhan will present her research on the kinds of mentoring, academic, and social interventions that keep females in STEM. She examines the GEMS (Girls EXCELLing in Math and Science) Mentoring program that encourages female undergraduates to major in STEM by engaging them within the industry they wish to work. Mika Munakata, Ken Wolff, and Mary Lou West -- with participating teachers -- will present findings from their GK-12 Fellows in the Middle project. This project matches STEM graduate students with middle school teachers in diverse New Jersey schools. Fellows and teachers design interdisciplinary inquiry units, prepare students for an annual Science/Math Day, and collaborate with scientists and teachers from other countries. Finally, Judith Lombana, Doris Ash, and Jrene Rahm will present a collaboration between Tampa's Museum of Science and Industry and UC Santa Cruz. They will discuss efforts to provide access to informal science for culturally and linguistically diverse learners. In particular, they will describe new instructional practices that give both educators and families power and access to science ideas and talk.

Strand 1: Science Learning, Understanding and Conceptual Change

S8.2 Uncovering Students' Ideas in Science

2:15pm – 3:45pm, Curacao 1

Presider: David F. Treagust, Curtin University

S8.2.1 U.S. and Colombian Students' Conceptions about Effects of Global Warming on Animals: A Cross-Cultural Study

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

ABSTRACT:

S8.2.2 Consistency of Students' Ideas about the Concept of Rate across Different Contexts

Behzat Bektasli, Hacettepe University, belizbektasli@gmail.com

Gultekin Cakmakci, Hacettepe University

ABSTRACT: This study presents empirical data about adolescents' common ideas on global warming across different cultural contexts (Midwest U.S. and Colombia). Data derived from an "interviews about instances" was analyzed using Constant Comparative Analysis. Results obtained thus far support the idea that students from different cultural contexts would likely hold different ideas about the same natural phenomenon, in this case, global warming and its effects on animals. Students' ideas were subjected to universal first-order constraints (e.g. polluting gases damage the ozone layer making the earth warmer). The way students satisfied these first-order constraints varied in the two sampled locations. Details of students' mental models might be culturally mediated (e.g. role of electricity in global warming). The findings from the present study can inform learning and instruction by providing domain-specific information about middle-school students' universal and culture specific mental models. Hence, theories of conceptual change could be refined and enriched. These findings are also relevant to the learning progression research program. Having a knowledge base of students' ideas in a specific domain, across different cultural contexts, has the potential to contribute to the

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incorporation of a cultural dimension to this line of inquiry, allowing more widespread usage of these theoretical models.

S8.2.3 Applying Cognitive Science to Assessment of Evolution Education

John E. Opfer, The Ohio State University, opfer.7@osu.edu

Ross H. Nehm, The Ohio State University

Judith S. Ridgway, The Ohio State University

Katherine Mollohan, The Ohio State University

Elizabeth Perrin, The Ohio State University

ABSTRACT: Natural selection is a core idea in biology, yet one that poses significant obstacles to students. To gain insight into students' problems with understanding of evolutionary change, we applied findings from cognitive science regarding student's understanding of individuals, categories and social behavior, and we hypothesized that these might give rise to cognitive biases that would affect evolution understanding. To test this hypothesis, we coded 576 explanations of evolutionary change for one of three cognitive biases (intentionality, teleology, and essentialism). We found that (1) these cognitive biases were frequent in student responses, (2) individual differences in cognitive biases for one set of items predicted cognitive biases for other items, and (3) items that are seldom examined in studies of evolution understanding were the ones that most strongly elicit cognitive biases (e.g., plant evolution and loss of traits). We conclude that cognitive biases are an important but under-assessed element in students' misconceptions regarding evolutionary change.

S8.2.4 The Earth as a Cosmic Body: Conceptual Understandings and Spatial Ability of Elementary/Middle Preservice Teachers

Alice (Jill) A. Black, Missouri State University, ablack@missouristate.edu

ABSTRACT: This quantitative study investigated relationships among preservice elementary/middle teachers' ideas about Earth shape and gravity and their scores on tests of spatial ability and overall Earth science conceptual understanding. The What Are Your Ideas About the Earth instrument previously used with children was lengthened and used as an instrument (AWIE), as were the Purdue Visualization of Rotations (PVOR) and Earth Science Concepts (ESC) test. Instruments were administered to 238 preservice teachers. Results showed significant positive correlations among scores of all three tests. Correlations of AWIE questions or subtests with ESC and PVOR scores were significant for all but one item. Results indicated that a hypothetical gravity question involving small scale (far distance) views of Earth was the question most strongly correlated with spatial ability scores and general Earth science conceptual understanding. Adult preservice teachers scored only 65% (average) on a test originally administered only to children. Factors leading to scores and relationships of various test questions are analyzed. Results suggest the importance of uncovering preservice teachers' misconceptions and of stressing spatial relationships and scale in teaching the Earth sciences.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S8.3 Argumentation and Reasoning

2:15pm – 3:45pm, Curacao 2

President: Vincent Amodeo, University at Albany

S8.3.1 Embodied Experiences as a Resource for Children's Mechanistic and Mathematical Reasoning in an Engineering Curriculum

Molly S. Bolger, Vanderbilt University, molly.bolger@vanderbilt.edu

Paul J. Weinberg, Vanderbilt University

Marta A. Kobiela, Vanderbilt University

Robert J. Rouse, Vanderbilt University

Richard Lehrer, Vanderbilt University

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ABSTRACT: Although simple mechanisms are commonplace, reasoning about how they work—mechanistic reasoning—is often challenging. To foster mechanistic reasoning, we engaged third- and sixth-graders in the design of kinetic toys that consisted of systems of links and pivots. In a previous study we investigated children’s naïve explanations of these systems. We found that while children did exhibit some mechanistic reasoning about the linkages, and such reasoning was associated with their ability to predict linkage motion, particular features - including rotation and constraint of links - were often absent from their explanations. To make the workings of these systems more visible, we designed instruction which included forms of activity that we conjectured would afford bodily experience of these features. Students then progressively re-described and inscribed these embodied experiences as mathematical systems. We report a comparative case study of three students, tracing how embodying and mathematizing motion supported the development of mechanistic reasoning about how linkage systems work. Ongoing analysis includes microgenetic coding of student mathematical and mechanistic reasoning during instruction for these three students and others.

S8.3.2 Seeing the Invisible: Body Semiotics of Knowing and Learning Science/Mathematics

Sungwon Hwang, Nanyang Technological University, Singapore, sungwon.hwang@nie.edu.sg

Michael Wolff-Roth, University of Victoria, Canada

ABSTRACT: Researchers approach scientific/mathematical sense-making by using theories that are constructed after the fact, independent of the real-time interaction from which they emerge. Making sense of meaning (sense) development in this manner leaves little room to articulate generative aspects of teaching and learning in which heterogeneous sense-making resources are made available by and to students in communication. In this study, we take a perspective that does not theorize meaning (sense) as dependent of a specific form of representation (e.g., words) but considers different, irreducible modes of communication as an integrated whole. We exemplify the central role of the living body in students' coming to see the invisible (unknown). We explicate sense-making as performances (which we observe) rather than changes in mental structures (which nobody can observe). This way of understanding enables us to find a genetically emerging meaning unit that is irreducible to and non-representative of precedent; it constitutes a growth point of sense-making. We exemplify this approach with a case study of elementary mathematics in which students learn about three-dimensional geometrical objects. Our examples present sense-making process that appears from the bodily and embodied translation of different resources such as speech, gestures, and material bodies in the setting (e.g., representations).

S8.3.3 Trends in Research on Argumentation: Content Analysis of Science Education Journals

Sibel Erduran, University of Bristol, United Kingdom, Sibel.Erduran@bristol.ac.uk

Yasemin Ozdem, Middle East Technical University, Turkey

Jee Young Park, Seoul National University, Korea

ABSTRACT: Content analysis of journals provides researchers with insight into recent and emerging trends of key themes in the literature. For example, Lee et al. (2009) have identified ‘argumentation’ as an area of research in science education that has “gained significant attention” in recent years (p.2016). Content analysis of research can also be useful in forging new interpretations of the literature and providing synthesis of ideas. The primary objective of this paper is to review argumentation studies in science education published from 1998 to 2009 in key science education journals. In recent years, the teaching and learning argumentation has emerged as a significant educational goal. The case made is that argumentation is a critically important discourse process in science and that it should be taught and learned in the science classroom as part of the learning of scientific inquiry and literacy (Duschl & Osborne, 2002). Our aim in this study was to investigate how ‘argumentation’ has been positioned within top academic journals: Science Education, International Journal of Science Education, and Journal of Research in Science Teaching. We have carried out analyses of journals on the basis of epistemic, linguistic and social aspects of argumentation. Results in the trends will be discussed.

S8.3.4 Understanding the Challenges Faced by 6th Grade Turkish Science Students While Developing Written Arguments

Fatma Caner, canerfatma@gmail.com

Mehmet Aydeniz

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ABSTRACT: The purpose of this study was to understand the challenges faced by 6th grade Turkish students in developing written arguments and the impact of collaborative argument development on the quality of arguments developed by the students. The study took place in a 6th grade science classroom consisting of 22 students. The results show that students experience significant challenge in developing written arguments individually. The same results show that the quality of written arguments got better after the students participated in a collaborative verbal argument development. The discussion focuses on factors that may help students to successfully appropriate the epistemic and social norms of science in the classroom.

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

S8.4 Related Paper Set - Teaching Evolution to Young Children: Rethinking Pedagogy and Possible Understandings

2:15pm – 3:45pm, Curacao 3

Presider: Kathleen E. Metz, University of California, Berkeley

ABSTRACT: These papers examine understandings of ideas of evolution that 2nd and 3rd graders achieve, given a radically different instructional model that more fully capitalizes on their capabilities to understand abstract ideas and use these ideas in the practices of science. The instructional model is based on pedagogical design principles and a learning progression of increasingly powerful explanations of the fit between organisms and their environment. These together guide iteratively refined project curriculum for scaffolding children's study and application of the targeted ideas in thought experiments, empirical and text-based investigations in the study of animals and their behavior or botany. One paper describes the instructional model and examines the children's emergent competence through the lens of the learning progression. A second paper more closely examines this model of science instruction for young children, through analysis of prototypic instructional activities. A third paper focuses on the instructional use of external representations to support the challenging ideas targeted in the learning progression. A fourth paper examines the children's learning from the perspective of reflection of buggy explanations and how these decrease given participation in the project curriculum. The papers together challenge strong prevailing assumptions about "age appropriate" science curriculum for primary grade children.

S8.4.1 Instruction and Student Outcomes Through the Lens Of Pedagogical Design Principles and Learning Progression

Kathleen E. Metz, University of California, Berkeley

S8.4.2 So What Happens in the Classroom? Analysis of a Prototype Activity Structures to Support Reasoning About Natural Selection

Stephanie Sisk-Hilton, San Francisco State University

Eric Berson, University of California, Berkeley

S8.4.3 Iterative Design of Visual Representations to Support Young Children

Nicole Wong, University of California, Berkeley

S8.4.4 Teleological, Personification, and Essence-Transformationist Challenges: Impact of the Instruction on Children

Uyen Ly, University of California, Berkeley

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

S8.5 Scientific Inquiry in the Classroom and the Field

2:15pm – 3:45pm, Curacao 4

Presider: Jaimie Miller-Friedmann, Harvard University

S8.5.1 Inquiry based Science and Technology Enrichment Program for Female Middle School Students

Hanna Kim, DePaul University, hkim13@depaul.edu

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ABSTRACT: This study investigated the effectiveness of guided inquiry integrated with technology, in terms of female middle-school students' attitudes toward science/scientists and content knowledge regarding selective science concepts (e.g., DNA, Force & Motion, Latitude & Longitude, and Water Quality). Female students who were entering eighth grade attended an intensive, one-week Inquiry-Based Science and Technology Enrichment Program (InSTEP). We used pre- and post-attitude surveys, drawings of a scientist/scientists, pre- and post-content knowledge tests, and selective interviews to collect data and measure changes in 123 female students' attitudes and content knowledge. A within-group, repeated-measure design was conducted, and the results indicated that InSTEP, which used guided inquiry integrated with technology, had a positive effect on participants' attitudes toward science, science-related careers, and content knowledge of selected science concepts.

S8.5.2 Linking Pedagogy to Practice: Improving Student Motivation and Academic Performance in STEM Courses Through Inquiry-Based Instruction

Amanda D. Wimpey, Palmetto High School Mathematics Instructor, WimpeyM@anderson1.k12.sc.us

Lisa C. Benson, Clemson University

Carol H. Wade, Clemson University

ABSTRACT: This study examined student motivation and academic performance data from middle and high school students enrolled in science and mathematics courses where inquiry-based instruction was implemented. The instructional materials were developed through an NSF-funded Research Experience for Teachers (RET) program that allows mathematics and science teachers to perform authentic laboratory research and bring those experiences into their classrooms. Participants developed inquiry-based instructional modules with the goal of bolstering student motivation and academic performance in the science, technology, engineering, and mathematics (STEM) content areas. Inquiry-based instruction is noted for its increased effectiveness over its traditional counterpart in improving academic performance and the development of thinking and problem-solving skills in college students. We hypothesized that the use of inquiry-based instruction developed as an outcome of participation in an RET program will provide for increased student motivation and academic performance for students enrolled in STEM courses. The study found significant results in 2 of 4 motivation constructs studied (intrinsic value and expectancy), and higher gains in academic performance for students in two of the classes studied (algebra I and physical science).

S8.5.3 Using Discrepant Events as Science Demonstrations to Promote Engagement and Develop Meaningful Student-Led Inquiry Investigations

Vincent Mancuso, Brighton Central School District- Rochester, NY, vince_mancuso@bcsd.org

ABSTRACT: Employing action research as a methodology, this study explored how science demonstrations can be designed to most effectively promote student engagement in scientific investigations. More specifically, the study examined the effects of using discrepant events as demonstrations to create cognitive conflict that can initiate meaningful student-led investigations. It also investigated the relative merit of the well-researched POE (Predict, Observe, Explain) design versus demonstrations that appear to the student as unplanned (NOE, or Naturally Occurring Experience). The action research focused on an intervention consisting of three instructional units on density, molecular arrangement of gas particles, and cohesion. In each unit, students were asked to design and conduct an investigation of the concept. In one case the investigation was preceded by a discrepant event demonstration using POE, in another the investigation was preceded by an NOE discrepant event demonstration, and in the third case it was preceded by a lecture. The three scenarios were compared looking at a rich set of qualitative data. Findings revealed that discrepant event demonstrations were effective in inspiring rich science investigations, especially with respect to identifying worthwhile variables and questions to be explored. Each lesson design (i.e., POE versus NOE) offered valuable yet distinct benefits.

S8.5.4 Teaching and Learning in the Urban Wild: Teachers Leading Field Investigations with Secondary School Students

Amanda P. Jaksha, University of Arizona, College of Education, ajaksha@email.arizona.edu

Christopher J. Harris, Center for Technology in Learning, SRI International

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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 their school science tasks and activities. This study closely examined five teachers enacting field investigations with their secondary students during a yearlong urban ecology course and the strategies they employed when dilemmas of practice were encountered. Video records and observation notes taken during field investigations were used to identify dilemmas encountered during field investigations and strategies teachers used to address such dilemmas. Analysis of strategies focused around four central dilemmas of practice for teachers: (1) structuring the field experience, (2) managing time and pace while outside, (3) establishing norms for learning in the field, and (4) using questioning effectively to prompt thinking and sustain learning during investigations. Findings show that some teachers were more successful than others at addressing dilemmas of practice. These findings offer important contributions toward building our understanding of how teachers can effectively orchestrate field science with high school students.

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

S8.6 Collaborative Learning in College Science Courses

2:15pm – 3:45pm, Curacao 5

President: Sameer Honwad, Rutgers University

S8.6.1 Student Interactions and Approaches to Studying in Self-Formed Study Groups

Karen Christian, University of Arizona, christik@email.arizona.edu

Vicente Talanquer, University of Arizona

ABSTRACT: Students often use study groups to prepare for class or exams; yet to date, we know very little about how these groups actually function. This study looks at the ways in which undergraduate organic chemistry students prepare for exams through self-formed study groups. In particular, we made observations of 14 groups of students throughout their first semester of organic chemistry. These first-hand observations gave us a means to qualitatively understand how students interact and collaborate, and how this affects the ways in which they engage with chemistry concepts and ideas. Our analysis showed that groups engage in predominantly three types of interactions when discussing chemistry content: co-construction, teaching, and tutoring. Although each group engaged in each of these types of interactions at some point, their occurrence varied between groups and group members. Our analysis suggests that the types of interactions that were most common depended on the relative content knowledge of the group members as well as on the difficulty of the tasks in which they are engaged. Overall, results from this study may help instructors to construct appropriate tasks to guide what and how students study outside of the classroom.

S8.6.2 The Effect of Collaborative Group Testing on the Performance and Perceptions of Students in a Biotechnology Course for Non-Majors

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

Carina M. Rebello, University of Missouri

Stephen B. Witzig, University of Missouri

Marcelle A. Siegel, University of Missouri

Sharyn K. Freyermuth, University of Missouri

Kemal Izci, University of Missouri

ABSTRACT: The goal of this mixed methods study was to determine the effect of using collaborative group testing on student scores and perceptions in an introductory undergraduate biotechnology course. There were three exams given during the course and this study compared scores of 114 students on paired individual and group test questions that were designed to elicit understanding of similar concepts. Nine students were selected based on test performance for semi-structured interviews about their experiences

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and perceptions regarding group testing. Findings showed statistically significant improvement on scores on the group questions of Exams 2 and 3 ($p < .001$). Student interviews found that students recognized both advantages (hearing other opinions, sharing ideas) and disadvantages (resolving differing opinions, relying on others) of group testing. Students also reported mixed opinions about whether they preferred group testing to individual testing and whether groups should be assigned. Students were also able to recognize the utility of group testing and were able to conceptualize additional contexts where it could prove beneficial. Our collective findings suggest that collaborative group testing can be used as a novel, alternative assessment strategy in college classrooms by improving student skills such as learning to work collaboratively, decreasing test anxiety, and improving communication.

S8.6.3 Collaborative Activities, Discourse and Self-Reported Learning of Students Working on Ill-Structured Capstone Projects

Nasser M. Juma, Kansas State University, mhuninas@phys.ksu.edu

Elizabeth Gire, University of Memphis

Brian Washburn, Kansas State University

Kristan Corwin, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: We examine how students' collaborative activities, discourse and self-reported learning differ depending on the structure of the capstone project that they work on. We completed a case study to investigate how two pairs of students in an upper-division undergraduate physics laboratory collaborate to come up with ideas on two capstone projects that differ in content and structure. One pair completed a capstone project which built on an existing experiment that the students did in an earlier course, while the other pair of students completed a capstone project which did not build on an existing experiment. Our analysis of the discussion between pairs of students working on these two capstone projects has indicated that the structure of these capstone projects leads to a difference in the types of statements made during the discussion. We find that students working on the familiar or hence more structured capstone project made more statements that present information or ideas while students working on the unfamiliar and hence less structured capstone asked more questions and made fewer statements that present information or ideas. However, we find that students in both capstone projects made very few statements demonstrating that they evaluated or reflected upon their ideas.

S8.6.4 Self-Directed Learner Development Through Project-Based Learning Environment: A Comparative Study of Engineering and Physics Courses

Jennifer A. Simonovich, F. W. Olin College of Engineering, jennifer.simonovich@students.olin.edu

Emily Towers, F. W. Olin College of Engineering

Yevgeniya V. Zastavker, F. W. Olin College of Engineering

ABSTRACT: Since its inception, Project-Based Learning (PjBL) has shown to be an effective method to enhance student learning, including science and engineering (S&E) fields. However, the specific implementation of a PjBL course plays the deciding role in its outcomes and their effects have not been systematically studied. This paper presents a comparative study of two PjBL courses, Engineering Design and Physics Laboratory, with similar course goals and design but varying in terms of the implementation. Specifically, the PjBL aspects related to self-direction and student autonomy are investigated. The following research questions are addressed: 1) How do the specifics of course implementation, as classified by PjBL, influence students' attitudes towards their S&E courses? 2) To what extent are the differences in the PjBL course implementations related to disparities in students' performance, interest, and participation (PIP) in those courses? We further discuss the implications of these differences in students' PIP and argue for a more comprehensive model of PjBL and its implementation in introductory college-level S&E courses.

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Strand 6: Science Learning in Informal Contexts

S8.7 Towards Increased Understanding of Epistemology and Cognition in Informal Science Education

2:15pm – 3:45pm, Curacao 6

Presider: Martin Storksdieck, National Research Council

S8.7.1 Shooting Stars and Matching Games: Audiences' Understanding of Scientific Terms and Concepts in a Planetarium

Jean Creighton, University of Wisconsin-Milwaukee Planetarium, jean@gravity.phys.uwm.edu

Sandra T. Martell, University of Wisconsin

ABSTRACT: The purpose of the study was to investigate whether or not using a cognitive apprenticeship approach (Sawyer, 2006) to teaching astronomy impacts planetarium visitor understanding of scientific terminology and the ability to make connections across terms. The authors describe a research study whereby one half of planetarium visitors to a show about shooting stars was exposed to cognitive scaffolding and one half was not. They discuss the use of a tool – a questionnaire - designed to measure learner self- perceptions of understanding and acquisition of astronomical content compared with demonstrated ability to match terms and articulate connections. Findings include that learners are better able to connect a term with its definition than to write about the connections between terms. The treatment group had more sophisticated answers than the control group, although the two groups did similarly well in connecting terms with their definitions. And, the most sophisticated written answers were given by people who thought more explanation of terms was required. Science educators, therefore, need to foster metacognitive awareness, continuously examining whether or not a concept is understood by learners. Scientists evaluate their understanding often and it would be useful to model this to their audiences.

S8.7.2 Socio-Cognitive Scaffolding in the Studio: Informal STEM Learning and Identity

Carol B. Brandt, Virginia Polytechnic Institute and State University, cbbrandt@vt.edu

Andrea Motto, Virginia Polytechnic Institute and State University

Christine Schnittka, University of Kentucky

Michael A. Evans, Virginia Polytechnic Institute and State University

Brett D. Jones, Virginia Polytechnic Institute and State University

ABSTRACT: In our development of an out-of-school program in science, technology, engineering, and math (STEM) education for underserved youth (ages 11-15) in rural Appalachia, we learned that volunteer facilitators, recruited from science and engineering undergraduate programs at a large mid-Atlantic university, were critical to our success in improving students' attitudes toward, and their perception of being able to do engineering activities. In this paper, we explore the role of the facilitators in this out-of-school program with special attention to the ways these facilitators scaffolded learning through supportive dialogue as they worked with youth on their engineering projects. This research examines the socio-cognitive dimensions of learning that influence one's self-identification with science and engineering.

S8.7.3 The Development and Use of a Concept Mapping Assessment Tool with Young Children on Family Visits to a Live Butterfly Exhibit

Jennifer Mesa, University of Florida, uloa@ufl.edu

Linda Cronin-Jones, University of Florida

ABSTRACT: The purposes of this study were to develop a concept mapping assessment tool and to use this tool to document the butterfly-related knowledge of young children on unguided family visits to a live butterfly exhibit at a natural history museum. In this study, forty-two children visited the live butterfly exhibit and completed pre- and post-visit concept maps. During pre- and post-visit mapping sessions, children created and revised concept maps about butterflies using eight butterfly-related concept pictures and provided verbal explanations for each picture pair in their concept maps. Quantitative analyses of the scores indicate that three raters used the three scoring systems with a high level of consistency. The results also indicate that children significantly increased their butterfly-related knowledge in the live butterfly exhibit regardless of recent prior experience with the exhibit. Qualitative analyses of children's verbal

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explanations indicate that children possessed butterfly-related knowledge in many areas. Although children with different levels of exhibit experience showed similarly high levels of prior and subsequent knowledge, the types of understandings they communicated differed somewhat. Surprisingly, children without recent prior exhibit experience showed greater understanding in more areas of butterfly-related knowledge than children with recent prior exhibit experience.

S8.7.4 Learning in an Informal Context: An Epistemological Perspective

Marshall Karen Benn, Professor, karen.marshall@montgomerycollege.edu

ABSTRACT: This study reports the findings of a qualitative study within the model of out-of-school time (OST). This study explored how participation in an informal science program might affect the epistemology of science of upper elementary school children. A purposefully selected, maximum variation sample of five upper elementary school children who had participated in an OST science program was compared with five similarly selected upper elementary school children who had not participated in an OST science program. Semi-structured interviewing was the method of data collection. Findings reveal that upper elementary children exhibit some qualitative differences with respect to their epistemology of science. In general, OST participants had more advanced (sophisticated) epistemologies of science than non-OST participants. The theoretical perspective of epistemology employed in this study may shed new light on the ways in which OST science experiences might impact children's learning.

Strand 7: Pre-service Science Teacher Education

S8.8 Elements of Science Content and Methods Courses

2:15pm – 3:45pm, Curacao 7

Presider: Deborah C. Smith, The Pennsylvania State University

S8.8.1 Unpacking what Makes an Elementary Science Methods Course Practice-oriented

Ashima Mathur, University of Michigan, amath@umich.edu

ABSTRACT: Because pre-service teachers often struggle to translate theories about teaching and learning presented in university methods courses into effective classroom teaching, some teacher educators are embracing more practice-oriented approaches that bridge theory and practice. This paper focuses on the ways course activities in a practice-oriented science methods course created opportunities for pre-service teachers to develop the complex practice of guiding classroom discussions. Video records of course activities and pre-service teachers' written reflections were analyzed using an inductive approach of applying codes and identifying emerging patterns. Findings suggest that the practice of guiding science classroom discussions was made available to interns 1) by creating images of practice 2) through focused teaching experiences, and 3) through post-teaching debriefing sessions. Grossman and colleagues' framework for thinking about the teaching of practice (Grossman, Compton, Igra, Ronfeldt, Shahan, & Williamson, 2009) was applied to further unpack the strengths and weaknesses from each of the findings above. As practice-oriented approaches are being adopted by teacher education programs, there is a need to better define what it means to be "practice-oriented" and to provide examples of how teacher educators can better prepare pre-service teachers to enact complex science practices: this paper contributes to meeting this need.

S8.8.2 Idealization versus Reality in Elementary Science Methods Instruction: A Statewide Analysis

Carole K. Lee, University of Maine Farmington, yuen111222@hotmail.com

William F. McComas, University of Arkansas

ABSTRACT: This study aims to understand the design and implementation of elementary science methods instruction by teacher educators in the universities in Arkansas. All 18 institutions with an Elementary Education program approved by the Arkansas Department of Education were reviewed with interviews, site visits and data analysis. The reviews are based on the "ideal" recommendations made by the science teacher organizations and the science methods textbooks. The findings reveal the complexities and diverse nature of the method classes as they are affected by the perceptions and academic backgrounds of the teacher educators, and the science teaching pedagogy and content

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knowledge provided by the teacher educators. Results show that not all methods classes are focused mainly in science teaching methods and science knowledge. One common theme that emerges in the lesson observations is that all teacher educators use hands-on activities to illustrate the teaching of science. This study offers valuable insights for an "ideal" science methods class. To help teacher educators to be focused in preparing preservice elementary teachers in teaching science, it is recommended that the Arkansas Department of Education should provide guidelines on the curricula of an elementary science methods class.

S8.8.3 A Study on a Metacognitively Oriented Learning Environment in a Science Laboratory Course

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Hamide Ertepinar, Middle East Technical University

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The aim of this paper is to investigate if metacognitively embedded prompts help to create a metacognitively oriented learning environment in a science laboratory course. The data were collected from 28 Pre service science teachers (PSTs) who attended the science laboratory course in a large public university. Mixed research method approach was used to collect and analyze the data. To collect in dept data, interviews with 7 PSTs were made. Metacognitive prompts were used throughout the laboratory course which lasted 6 weeks to evoke PSTs' metacognition. Metacognitively learning environment was investigated in terms of 1) metacognitive demands, 2) student-student discourse, 3) student-teacher discourse, 4) student voice 5) distributed control 6) teacher encouragement and support 7) emotional support. It can be concluded from the study that metacognitively embedded prompts enable to create a metacognitively oriented classroom environment which supports the metacognitive development. Besides, PSTs stated that they questioned their learning more with the laboratory course. Furthermore, the interviews supported that this course helped PSTs develop their metacognitive skills.

Strand 7: Pre-service Science Teacher Education

S8.9 Topic-Specific Content Knowledge and Pedagogical Content Knowledge

2:15pm – 3:45pm, Bonaire 7

President: Eunmi Lee, DePaul University

S8.9.1 Exploring the Pre-Service Science and Technology Teachers' Technological Pedagogical Content Knowledge (TPCK) and Classroom Practices Involving the Topic of Photosynthesis and Cellular Respiration

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Osman N. Kaya, Firat University, Elazig-TURKEY

Omer Yilayaz, Firat University, Elazig-TURKEY

Selcuk Aydemir, Firat University, Elazig-TURKEY

Didem Karakaya, Firat University, Elazig-TURKEY

ABSTRACT: The purpose of this study was to explore the Pre-service Science and Technology Teachers' (PSTs) Technological Pedagogical Content Knowledge (TPCK) and their teaching practices in real classroom settings involving the topic of photosynthesis and cellular respiration. This study also investigated the relationships among the components of PSTs' TPCK and practical knowledge in middle school classrooms. 41 randomly selected PSTs (19 females and 22 males) in their final semester in a science teacher education program participated in the study. Data were collected from multiple sources, including open-ended questionnaires, semi-structured interviews, lesson plans, drawings for the PSTs' TPCK and classroom observation protocol, video records and field notes for the PSTs' teaching practices in middle school science classrooms. After exploring the PSTs' TPCK, teaching practices of the PSTs in science classrooms in four public middle schools were investigated. Findings obtained from the data showed that PSTs were lack of sufficient conceptual knowledge and views on nature of science and hold general alternative conceptions. It was found that PSTs' understandings of students' learning difficulties and topic-specific technological knowledge were very low. Data related to the PSTs' teaching practices in the middle school science classrooms indicated a success rate of about 42% - 57%.

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S8.9.2 Development of Pre-service Chemistry Teachers' Pedagogical Content Knowledge for Teaching Nature of Science

Betül Demirdögen, Zonguldak Karaelmas University, dbetul@metu.edu.tr

Esen Uzuntiryaki, Middle East Technical University

ABSTRACT: The purpose of this study is to delve into the complexities of development of preservice chemistry teachers' science teaching orientation, knowledge of learner, knowledge of instructional strategies, and knowledge of assessment during Pedagogical Content Knowledge for Nature of Science instruction. Nine preservice chemistry teachers enrolled Methods of Science Mathematics course participated to the study. Case study, one of the qualitative research methods, was used as research design. Pedagogical content knowledge for nature of science instruction spanned seven weeks including learning nature of science and learning how to teach nature of science parts. This study only involved the collection of qualitative data sources including responses given to an open ended instrument, interviews, observations, and documents such as lesson plans and reflection papers. The constant comparative method was used as data analysis method. The findings support the view that even when teachers have informed understandings of NOS consistent with reforms, they generally do not explicitly teach NOS, or may do so using didactic teaching approaches. In addition, analysis of reflection papers, microteachings, lesson plans, and take home assignments showed that although preservice teachers knowledgeable about dimensions of PCK, they were less successful to deal with misconceptions and assessment in their lessons.

S8.9.3 Pre-service Elementary Teachers' Misconceptions about Change and Constancy

Charlotte A. Otto, University of Michigan-Dearborn, cotto@umich.edu

Susan A. Everett, University of Michigan-Dearborn

ABSTRACT: Pre-service elementary teachers' understanding of the meaning of constancy and change were probed using a written questionnaire and a homework assignment. All students correctly defined constancy as a lack of change but some were unable to apply that definition. Some believed that constancy can include change as shown in responses such as "fairly constant" or "stays constant for the most part." Over 40% of the students wrote that human body temperature was constant, but in explaining their choice, they wrote that body temperature was constant unless you were ill. Processes such as the phases of the moon were viewed as an example of constancy, rather than cyclical change, by over 30% of the students because the process was repetitive. Students rarely included rates or patterns of change in defining change in their own words as a scientist would. We found that students did not recognize random events to be an example of change. The big ideas of change and constancy may seem to be so straightforward that no one has considered that there may be misconceptions about these terms. This study however, shows that even college seniors have alternative conceptions of change and constancy.

Strand 8: In-service Science Teacher Education

S8.10 Collaboration and Mentoring

2:15pm – 3:45pm, Curacao 8

President: Toth Eva Erdosne, West Virginia University

S8.10.1 Addressing Elementary Teacher Misconceptions in Science and Supporting Peer Learning through Curriculum Mapping

Michael Giamellaro, University of Colorado, Denver, michael.giamellaro@email.ucdenver.edu

Ruiz-Primo Maria Araceli, University of Colorado, Denver

Min Li, University of Washington, Seattle

ABSTRACT: Elementary school teachers may not always understand the science concepts they are expected to teach and may harbor misconceptions within the content. We present and evaluate a collaborative module mapping tool/process to help identify and address these gaps. Teachers use the mapping process in conjunction with 'science kits.' Observations of the mapping process, classroom instruction, and student test data (1) show that the mapping approach can be used to identify misconceptions held by teachers and support the co-construction of knowledge amongst

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teachers, (2) reveal a strong relationship between teacher knowledge and student performance, and (3) suggest the potential for correcting teacher misconceptions and thereby increasing student performance on assessments.

S8.10.2 Science Teacher Induction and Student Achievement in Science: Is There a Link?

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Carol L. Stuessy, Texas A&M University

Dane Bozeman, Texas A&M University

Tori Hollas, Texas A&M University

ABSTRACT: Mentoring and other induction activities are recommended to bridge the gap in science achievement that occurs in students who are taught by novice science teachers as compared with experts. While robust induction programs are suggested for new teachers, we currently do not have large-scale studies to (a) substantiate that a relationship exists between a high school's induction practices and its students' science achievement, or (b) identify specific induction practices associated with increases in students' science achievement. Using a sample of 50 schools to represent the 1,333 high schools in a large, geographically and culturally diverse state, this study answers two research questions dealing with (1) the extent of the support for new science teachers across the state's high schools and (2) the identification of induction practices that are significant predictors of students' science achievement (SPCR). An explanatory mixed methods design was used to investigate the relationship between schools' induction practices and their students' SPCR scores. Principals' interviews from the 50 sample schools were analyzed to gain an understanding of schools' induction policies and practices for their new science teachers. Results indicate a positive, statistically significant relationship between induction practices and SPCR and identify particular induction practices that significantly predict SPCR.

S8.10.3 Revisiting Vygotsky's Zone of Proximal Development in the context of In-service Science Teacher Education

Colette Murphy, Queen's University Belfast, c.a.murphy@qub.ac.uk

Kathryn Scantlebury, University of Delaware

ABSTRACT: This paper discusses the implications of a new analysis of Vygotsky's zone of proximal development (ZPD) for using coteaching and cogenerative dialogue as structures for science teachers' professional development and student teachers' pedagogical experiences. The authors adapt Tharp and Gallimore's (1991) ZPD model of automatization and recursion within a wider consideration of the ZPD to provide a theoretical framework for coteaching and cogenerative dialogue as professional development experiences in which teachers experience critical discourse about practice and authentic opportunities to learn more about and to 're-learn' teaching. Coteaching and cogenerative dialogues deconstruct power hierarchies between teachers, pre-service teachers and students, providing opportunities for reflective and recursive experiences that are located in a context which is rich in interactions between teachers and their students. The ZPD embraces all the elements that facilitate development from one stage of teacher development to the next. Teacher educators can help to establish conditions for ZPDs for teachers at different stages of their development in relation to each individual's specific direction(s) of development.

Strand 8: In-service Science Teacher Education

S8.11 Teaching in Multicultural Settings

2:15pm – 3:45pm, Bonaire 8

President: Cynthia Passmore, University of California, Davis

S8.11.1 The Road to Culturally Relevant Science: Exploring How Teachers Navigate Change in Pedagogy

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

Virginia Jennings, Utah State University

Tammy Miller, University of Cincinnati

ABSTRACT: In this study two middle school teachers who participated in a professional development program utilizing the Transformative Professional Development model are followed as they embarked upon becoming culturally relevant

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science teachers of Latino students. Using Ladson-Billings (1994) theory of culturally relevant pedagogy (CRP), teacher interviews, focus groups, journals, and field notes are examined to reveal aspects of CRP that the participants translate into their daily science instructional practice in this longitudinal case study. Findings revealed TPD enabled teachers to transform their practice to focus on more culturally relevant science pedagogy resulting in more effective instructional environments for their Latino students. Implications for further research on professional development and other supports for teachers integrating CRP are discussed.

S8.11.2 Job-embedded Professional Development for Urban Elementary Teachers: Lessons Learned from Year One of a Multi-year School-university Partnership

Jeffrey C. Nordine, Trinity University, jnordine@trinity.edu

Patricia Norman, Trinity University

ABSTRACT: We have begun a three-year partnership with an urban district to offer job-embedded professional development in science and mathematics at two elementary schools. Two university faculty members have spent one or two days per week at the schools planning with teachers, co-teaching, and collaborating with administrators. Our year one formative evaluation efforts have explored factors influencing science and math instruction at our partner schools, teachers' reaction the partnership, teacher efficacy, and student attitudes toward science and math. We found that access to materials and planning time were major challenges, but that teachers felt that the partnership gave them needed time, resources, and content knowledge. We also found that participants' feelings of efficacy about science teaching and their students' attitude toward science both increased at a statistically significant level. Seven teachers opted out of the partnership mid-year because they did not see sufficient benefit in participating; though not an equivalent comparison group, students of these teachers did not significantly improve their attitude toward science. Results suggest that our job-embedded professional development has positively affected teacher efficacy and student attitudes, and that our future efforts must focus on continuing to address challenges with teachers as they arise and on fostering teacher buy-in.

S8.11.3 Secondary Science Teachers' Translation of Professional Development through Affinity- and Institution-identity

Elizabeth B. Lewis, University of Nebraska-Lincoln, eb1@unlserve.unl.edu

ABSTRACT: This study provides greater detail concerning how science teachers did, or did not, use a professional development model of a scientific classroom discourse community with their students. Two biology teachers, Cathy and David, from the same urban high school, were the subjects of two case studies. Identity was used as an analytic lens to consider teachers in the dual contexts of their classroom environment and professional development. Over time, as Cathy adopted the inquiry-based instructional practices she learned at the professional development seminars, her professional identity became more aligned with the norms and affinity group teaching philosophy and instructional practices of the professional development. David seemed to enjoy his interactions with the professional development, but ultimately, as seen in observations of his science lessons, he adapted the professional development strategies to fit his prior traditional mode of teaching. Consequently, Cathy moved away from her pre-professional development institution identity that was more aligned with the high-stakes testing culture of her school where skill-and-drill, cookbook activities were valued for rote learning. David's affinity identity remained aligned with his institution identity and the professional development had little effect on his instructional practices.

Strand 9: Reflective Practice

S8.12 Related Paper Set - Meta-reflecting on the Realities of Curriculum and Teaching: Stories from Singapore

2:15pm – 3:45pm, Bonaire 6

Presenter: Tang Wee Teo, University of Illinois

ABSTRACT: In this related paper set, we engage four Singapore teachers—Jessie, Kathy, Sona, and Gordon—with different teacher roles, years of teaching experience, qualifications, and school contexts as research collaborators in reflections and meta-reflections of their curriculum and teaching. We purposefully generated questions and comments from their

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narratives of experiences. Progressive focusing on critical issues such as imbalanced power relations in curricular decisions and considerations given to gender, race, ethnicity, and class differences were asked. As they recursively 'reflect', new or revised thoughts were invoked, revealing gaps and contradictions. Hence, we problematize reflections from a comfortable story-telling process to one that is uncomfortable, unsettling, and thought-provoking for teachers. We do this by reciprocating making them feel safe about revealing what they thought was controversial or oppressive. For example, Jessie revealed her school did not have a "curriculum" as teachers adhered to fixed syllabus. This process of engaging teachers in reflections and meta-reflections could have emancipatory effect as critical insights and actions to improve practice under the constraints of a national curriculum were invoked. This study illuminates problems, issues, and dilemmas Singapore teachers faced and how teachers could be supported to become more reflexive practitioners in the context of standardized testing.

S8.12.1 Meta-reflecting on the Realities of Curriculum and Teaching: Stories from Singapore

Aik-Ling Tan, National Institute of Education

S8.12.2 Two Mirrors Facing Each Other

Lee-Jiun Karen Ng, St Theresa's Convent

S8.12.3 Finally Someone is Listening

Lay Khim, Jasmine Tan, Greendale Primary School

S8.12.4 From Personal and Private Reflection to Dialogic Reflection

Song Ling Yong, Henry Park Primary School

S8.12.5 Developing a Deeper Appreciation through Teaching

Guohui Ng, St Theresa's Convent

Strand 10: Curriculum, Evaluation, and Assessment

S8.13 Scientific Inquiry Instruction and Assessment

2:15pm – 3:45pm, Bonaire 1

Presider: Senay Purzer, Purdue University

S8.13.1 Examining the Effect of Inquiry-Based Teaching on Students' Motivation, Science Self-Efficacy, and Science Achievement

Nai-En Tang, University of Missouri, naientang@gmail.com

Lloyd H. Barrow, University of Missouri

Chia-Lin Tsai, University of Missouri

ABSTRACT: Inquiry-based teaching has been proved to be an effective approach for teaching science. Several studies have investigated students' outcomes (e.g. achievement, motivation, self-efficacy) as results of inquiry-based teaching. Although current literature has explored the relationship between inquiry-based teaching and students' outcomes, only few take into consideration of the levels of exposure to the inquiry-based curriculum. Thus, the study investigated the effect of different levels of inquiry-based teaching on students' outcomes. This study used TIMSS 2003 dataset to investigate the relationship between Inquiry-based teaching and students' motivation, science self-efficacy, and science achievement. We divided students by high and low level of inquiry-based teaching groups based on student's perception. A two-step structural equation modeling approach was conducted to examine the factor mean and the path value. The results showed that students from the high inquiry-based teaching group had significantly higher mean on science self-efficacy and higher mean on science motivation. However, no difference was found in students' science achievement between high and low inquiry-based teaching groups. Moreover, high level of inquiry-based teaching leads

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to stronger effect of science self-efficacy on science achievement, while both self-efficacy and motivation are predictors of students' achievement in the low inquiry-based teaching group.

S8.13.2 Teachers' Cumulative Curriculum Implementation Experience, Fidelity of Implementation, and Student Learning

Hee-Sun Lee, Tufts University, University of California, Berkeley, heesun.lee@tufts.edu

Ou L. Liu, Educational Testing Service

Keisha Varma, University of Minnesota

Marcia C. Linn, University of California, Berkeley

ABSTRACT: We investigated how teachers' curriculum implementation experience with inquiry-based instruction was associated with students' science learning. A total of 140 teachers administered year-end tests to their students (N = 18,454) in six science subject areas over a four year period. Among these teachers, 118 teachers implemented one or more short-duration, visualization-rich, inquiry-based science curriculum modules, accumulating different years of curriculum implementation experience. Student learning was measured on the knowledge integration construct based on the Rasch Partial Credit Model. A teacher's curriculum implementation experience was measured as the number of times a module or modules had been taught by the teacher. Using a mixed model ANOVA, we analyzed student learning by considering students' gender, English language learner (ELL) status, and technology use along with teachers and their curriculum implementation experience. Results show that student learning was significantly related to teacher and students' ELL status and technology use. A significant interaction effect between teacher and curriculum implementation experience shows differential impacts of curriculum implementation experience on student learning across teachers. Further analysis indicates that increased student learning was significantly linked to increases in fidelity of module implementation as well as expanded uses of curriculum modules over time.

S8.13.3 Modeling and Assessing Scientific Methods

Nicole Wellnitz, Institute of Biology Education, nicole.wellnitz@uni-kassel.de

Jürgen Mayer, Institute of Biology Education

ABSTRACT: As an important educational goal, current science curricula demand the ability of students to understand and to conduct scientific investigations. Contrary to these requirements, the learning outcomes are far from satisfactory. The educational research concerning scientific inquiry focuses mostly on experimental skills, in particular the control and variation of variables. The doing of and understanding about scientific inquiry implies also the knowledge and understanding of different scientific methods. Not all biological phenomena can be solved with experiments. Depending on the underlying phenomenon, the resulting questions can be answered with further valid inquiry methods. Using the similarities and distinctions, typical scientific methods of biology – observation, comparing and experimentation – were differentiated in regard to their specific inner structure. This structure is used to develop a model to describe students' competencies and to serve a framework to help teachers and students developing competencies in scientific investigations. The competence model also serves as a possibility to evaluate inquiry competence with test items. Within a nationwide pilot-study, a competence test with 129 open ended and multiple-choice items was used in a multi-matrix design (N=629; 10th grade) to investigate student skills in inquiry methods.

S8.13.4 Comparative Analysis of Two Inquiry Observational Protocols: Striving to Understand the Quality of Inquiry-based Instruction

Jeff C. Marshall, Clemson University, marsha9@clemson.edu

Julie B. Smart, Presbyterian College

Christine Lotter, University of South Carolina

ABSTRACT: With inquiry being one of the central tenets of the National standards, we must have solid means to measure the quality of inquiry-based instruction being led in classrooms. Many instruments are available and used for this purpose, but many are either invalid or too global. This study sought to compare two observational protocols: Electronic Quality of Inquiry Protocol (EQUIP) and Reformed Teacher Observation Protocol (RTOP) with regard to reliability, validity, and utility associated with inquiry-based instruction. Analyses included studying item reliability, inter-

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rater reliability, factor analysis, correlation, and multiple regression of protocol items within the instruments and between the instruments. General findings suggest that both instruments have high item reliability; EQUIP showed higher inter-rater reliability and seems to be more valid for measuring inquiry-based instruction, while RTOP seems better suited for looking more globally at constructivist teaching practices. Additionally, EQUIP seems to have higher overall utility: useful for looking formatively at individual teaching practice as well as studying summative teacher growth or program effectiveness. Further, EQUIP's descriptive rubric provides immediate and targeted feedback to teachers, instructional leaders, and professional development facilitators. This feedback includes both a micro view (individual indicators) and a macro view (construct) of teaching practice.

Strand 11: Cultural, Social, and Gender Issues

S8.14 Students and Science: Attitudes and Participation in Discursive Practices

2:15pm – 3:45pm, Bonaire 2

Presider: Katie L. Brkich, University of Florida

S8.14.1 The Science Student Role: Exploring its Creation and Enactment through Interaction

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

Robert Bechtel, University of Alberta

Gregory Henkelman, University of Alberta

ABSTRACT: This study probes student and teacher language to examine how norms and expectations are produced and reproduced in a grade 5/6 science class. The researchers visited one classroom twice a week for nine months to observe science lessons (over 100 hours of audio and video recordings). Transcripts analysis was guided by linguistic discourse analysis, with attention paid to word choice, grammar structure, voice and stance. Despite teacher efforts to encourage sophisticated views of subjectivity and personal creativity in science, students cling to a conventional approach to engagement in science that emphasizes depersonalization and avoids subjective reports of reasoning and observation.

S8.14.2 Reproduction of Inequalities in the Teaching and Learning of Science

Anna Jobér, ESERA, anna.jober@mah.se

ABSTRACT: Being good at science is a qualification needed to reach prestigious higher education and societal positions. Since the pass rate in the science subjects is lower than in other school subjects and failure in school science subjects is correlated to low social class, it has been showed that science is a factor in the reproduction of an unequal society. The way science is taught and learned in schools thereby contributes to an unjust society where children from e.g. disadvantaged socioeconomic backgrounds have less chance to succeed. Thus, the overall aim of my research is to contribute to our understanding of how school science reproduces unequal structures in society. Data were collected at Swedish compulsory schools with ethnographic methods. Results were discussed and analysed using concepts derived from Bourdieu and Bernstein. Preliminary findings indicate that habitus play a role in the science classroom and influence how students react and respond to teaching instructions, goals and criteria. Moreover, the first analysis point out that when framing is weak, student with inappropriate cultural capital fails.

S8.14.3 Challenges of Korean Immigrant Students in Science Classroom Participation

Minjung Ryu, University of Maryland-College Park, mryu@umd.edu

ABSTRACT: In current trends of science education, participation in classroom discursive activities is considered to be essential to learn both science content and the process of doing science. Despite the importance of discursive participation in science learning, cultural and cross-cultural studies suggest that Asian students are quiet and this quietness may not be congruent with the discourse patterns of U.S. classrooms. Problematically, however, such cultural and cross-cultural studies often assume that people from an ethnic group share unique traits that are not easily altered. Furthermore, agency of individual members of cultural communities is rarely considered in understanding such perceived common traits or patterns of practices. In this study, I explore how Asian immigrant high school students characterize their participation in science classroom discursive practices. Using semi-structured interviews of four

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Korean immigrant students, I argue that the participants are not intrinsically quiet. Rather, they choose to talk or not to talk with consideration of their identities and the specific situation of speaking. The implication of the study will be discussed from theoretical and pedagogical perspectives.

S8.14.4 'There is no Chance for Personal Development in it'. Why Students Choose not to Study Science at Universities

Henriette T. Holmegaard, University of Copenhagen, htholmegaard@ind.ku.dk

Lars Ulriksen, University of Copenhagen

Lene M. Madsen, University of Copenhagen

ABSTRACT: Research shows that even if young people have an interest in science, technology and mathematics (STM) in high school, they do not opt for STM at higher education. Through the lenses of identity and drawing on narrative psychology, this paper focuses on students' perception of STM and how these relates to their choice of higher education. Semi-structured qualitative interviews were made with 38 students just before finishing high school. The interviews focused on the students' reflections on their choice of higher education. The analysis shows that even if students consider which career possibilities, the course of study should also provide a possibility for self development. In this respect STM appear to fall short as viable choices to make. The students experience STM as fixed, rigid, and with an emphasis on reproducing knowledge rather than developing knowledge. In the students' perspective choosing STM will only develop isolated, discipline-specific competences without stimulating personal development. However, the students do not reject science as such, but they do reject the way STM disciplines are presented. Curriculum reform therefore should not only focus on teaching methods, but on how to engage students in the content in a way that supports their developing themselves as individuals.

Strand 12: Educational Technology

S8.15 Use of Technology Artifacts as Means of Knowledge Construction

2:15pm – 3:45pm, Bonaire 3

President: Houbin Fang, University of Southern Mississippi

S8.15.1 Taking Drawing Digital: Using Student-generated Drawings to help Students Learn about Molecules

Jennifer L. Albert, North Carolina State University, jennifer_albert@ncsu.edu

Eric N. Wiebe, North Carolina State University

ABSTRACT: The study of chemistry inherently makes use of visualizations because the exact structure and components of atoms are educated guesses based on indirect measurement. Many misconceptions exist before students step into a classroom but some are the result of observations in the classroom (Sanger & Greenbowe, 1997). Mayer's Generative Theory of Textbook Design (Mayer, Steinhoff, Bower, & Mars, 1995) was developed to see how illustrations help students learn and was later expanded by Van Meter and Garner (2005) to investigate learner-generated drawings. This study sought to further investigate learner-generated drawing strategies and expand its use to computer-based drawing/modeling. In asking students to draw water boiling at the microscopic level, they revealed both understanding and misconceptions in their drawings. While drawing has proved to be valuable in both the pen/paper and computer-based formats, further research may better shed light on the possible benefits of computer-based drawing tools over the traditional pen/paper format.

S8.15.2 Show Me the Evolution! Assessing Effectiveness of a New Teaching Resource

Anastasia Thanukos, University of Berkeley

Lauren Kendall, University of North Carolina at Chapel Hill

ABSTRACT: A multi-media program, Evolution in the News, from the University of California Museum of Paleontology's Understanding Evolution project and the National Evolutionary Synthesis Center gives educators a creative approach to communicating cutting edge evolutionary research, the relevance of evolutionary biology in everyday life, and the pervasiveness of evolutionary theory in informing and enabling advances in other disciplines. Targeting an undergraduate audience, the program uses a current news item as a jumping off point each month to showcase an

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important evolutionary concept, integrating an illustrated article, a multimedia podcast featuring scientist interviews, supporting educational materials, and links to popular and scientific literature. The pilot of this collaboration has shown promise, garnering more than 30,000 page requests during its first month. Given the challenging nature of the subject matter and the mixed media approach, we wanted to assess the effectiveness of the program in engaging students and increasing their understanding of evolutionary concepts. We will report on an initial assessment of the effectiveness of the program and how this information will be used to improve it.

S8.15.3 Co-Constructing Knowledge Artifacts for Understanding the Physiology of Human System Diseases

Vanessa L. Peters, University of Michigan, vlpeters@umich.edu

ABSTRACT: This study investigated how the construction of shared knowledge artifacts contributed to students' understanding of the physiology of human system diseases. Using a co-design approach, the researchers collaborated with two secondary science teachers to design a wiki-based biology lesson where students co-constructed knowledge artifacts about human diseases and disorders. Students then drew upon these artifacts as the main resources for a subsequent inquiry activity. Data were drawn from the following sources: peer-created knowledge artifacts, teacher and student interviews, and students' scores on the final biology exam. Quantitative data were used to investigate student achievement and evaluate the success of collaborative knowledge construction, while teacher and student interviews provided insight into their experiences with the activity. An analysis of the data suggests that the co-construction of shared artifacts fostered collaborative knowledge construction as well as individual student learning. Implications of this study for secondary school science are discussed.

S8.15.4 Hands-on Activities and the Use of Video Clips for Learning How to Identify Fish Species in an Aquarium

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

Katharina Scheiter, Knowledge Media Research Center, Tuebingen, Germany

Angela Sandmann, University of Duisburg-Essen, Germany

Sven Gemballa, University of Tuebingen, Germany

ABSTRACT: This study compared three different instructional materials for learning how to identify fish species in a public aquarium. During an initial classroom phase, learners prepared with one of the following learning materials: (1) preserved specimens and identification keys, (2) digital videos or (3) digital videos with preserved specimens and paper-based identification keys. Subsequently, all students visited a public aquarium where they identified the species that they had learnt before. Students' acquisition of knowledge and their motivation were measured once after preparing in the classroom and once again after visiting the aquarium. Our results indicate that students who had prepared themselves with digital videos identified significantly more species correctly but were less motivated than those, who had learnt only with preserved specimens and identification keys. When both instructional materials were combined students performed well in the posttests and were motivated to learn suggesting that the combination of both instructional approaches encourages motivation without any outcome losses.

Strand 13: History, Philosophy, and Sociology of Science

S8.16 Strand Sponsored Symposium - Applying Research in the Science Classroom: An Overview of Approaches to Teaching Nature of Science

2:15pm – 3:45pm, Bonaire 4

Presenters:

Norman G. Lederman, Illinois Institute of Technology

Sherry A. Southerland, Florida State University

ABSTRACT: The purpose of this session is to present a broad overview of approaches to teaching the nature of science in science classrooms. The session will begin with a general overview of the various models that are currently employed—implicit, history of science, explicit/reflective—lighting the research that explores their effectiveness for supporting student learning. Teachers and teacher educators that have employed one of these strategies will describe their application of the models—descriptions augmented by lesson plans, activities and/or assessments, and data that

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explores their influence. Finally, audience members will be invited to contribute their own classroom applications of Nature of Science.

Strand 14: Environmental Education

S8.17 Socio-scientific Issues: Addressing Controversy, Ethics, and Decision-making through the Environment

2:15pm – 3:45pm, Bonaire 5

President: Maurice DiGiuseppe, University of Ontario Institute of Technology (UOIT)

S8.17.1 Fostering Decision-Making Competence in Socio-Scientific Issues Concerning Sustainable Development: An Intervention Study

Helge Gresch, hgresch@uni-goettingen.de

Marcus Hasselhorn

Susanne Bögeholz

ABSTRACT: Dealing with socio-scientific issues in science classes is essential to enable students to participate in controversial discussions concerning sustainable development and other ethical topics. In this respect, well structured decision-making processes are an essential requirement for elaborate reasoning. To foster decision-making competence, a computer-based program was designed, which trains secondary school students in various decision-making strategies. In addition, an element of self-regulated learning was included: a guideline how to conduct a task analysis before the decision-making process. To prove the effects of this program 386 students were tested in a pre-post-follow-up design, which included two training groups (strategic training / strategic training combined with task analysis) and a control group (decisions with additional ecological information instead of strategic training). Effects were measured with a questionnaire about decision-making competence in situations related to sustainable development. It could be shown that both training versions improved the level of competence significantly. However, the inclusion of the element of self-regulated learning did not have an additional effect.

S8.17.2 The Effects of Argumentation and Traditional-Based Courses on Preservice Science Teachers' Knowledge about Climate Change Issue and Attitudes towards Environment

Mustafa S. Topcu, Yuzuncu Yil University, msamitopcu@gmail.com

Dilek Karisan, Yuzuncu Yil University

ABSTRACT: The purpose of the current study is to explore the effects of the argumentation and the traditional-based courses on Preservice Science Teachers' (PST) understandings of the climate change issue and their attitudes towards environment. The participants of the study were 38 PST (70% female) from a large University in Turkey. All students were fourth-grade preservice teachers from the department of elementary science teacher education enrolled science methods course. This course consisted of two sections: the first section consisted of 18 PST who took the traditional (lecturing)-based instruction, and the second section consisted of 20 PST who took the argumentation-based instruction. Two instruments, global warming knowledge scale and environmental attitude scale were used in the present study to address the research questions. Findings indicated statistically significant differences between pre- and post-test knowledge scores about global climate change for both groups. Moreover, a knowledge gain of 17 percent in the argumentation-based instruction group showed more increased degree of sophistication regarding knowledge of the climate change issue than the traditional-based instruction group. On the other hand, only the argumentation based-course created a significant change in PST's attitudes towards environment.

S8.17.3 Analyzing Yorktown's GloFish® Ethics: EcoJustice through Socioscientific Issues (SSI)

Michael P. Mueller, University of Georgia, mmueller@uga.edu

Dana L. Zeidler, University of South Florida

ABSTRACT: Socioscientific issues (SSI) provide situations where science teachers and students analyze complex issues associated with ethical, political, and social dilemmas. While engaging in SSI, students become informed about scientific conditions and develop epistemological styles for dealing with scientific research and the consequences thereof. During

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a time of increasing awareness around cultural diversity, biodiversity, and ecological degradations, epistemic development is paramount for helping students evaluate how they frame their relationships with others including nonhuman species and physical environments. The first premise of this paper is that ecojustice offers a diversity of perspectives needed by stakeholders for local policy and school reform. The second premise of this chapter rests on the idea that SSI can provide a contextualized learning environment for understanding the complexity of living and non-living interrelationship. Our third point is that, the literature shows that SSI cultivate moral-ethical reasoning and the development of character, which should be part of school sciences. With increasing genetically modified organisms such as Yorktown Technologies' patented GloFish™ making their way into classrooms, SSI and reasoning can better serve as an effective strategy for analyzing the moral and scientific concepts embedded within this issue, developing a sense of character, and considering obligations to life proper.

S8.17.4 Turning Citizen Science on it's Head: Exploring the Philosophy of Connecting People and Nature

Jenkins L. Lynda, Dalton State College, ljenkins@daltonstate.edu

Michael P. Mueller, University of Georgia

ABSTRACT: With the emerging trend of citizen science in environmental and science education, there is an interesting dilemma for educators to consider. This dilemma involves defining the meaningful purpose of engaging in citizen science with youth ---is it scientific literacy, inquiry skills, content knowledge, or something else such as increasing motivation and positive attitudes towards science and environments? With this idea in mind, we explore the literature base surrounding citizen science that indicates only a slight relationship between citizen science, developing scientific literacy, and positive attitudes towards science and the environment. However, supported by this literature is that individuals who develop science content knowledge (e.g., bird biology) already possess ethics and motivation towards doing science and caring for the environment. Interestingly, the faculty of one environmental education center painted a different picture of citizen science aims for teachers who participated in a week-long session. They focused on environmental monitoring skills (another way of saying 'citizen science'), cultural and environmental interpretation, and natural history. To do this they involve students in ongoing citizen science projects including water quality monitoring, and salamander monitoring to formulate these motivations. We explore this ideology of "connecting people and nature" in this presentation.

Strand 15: Policy

S8.18 Policy Implementation

2:15pm – 3:45pm, Antigua 2

President: Sharon Lynch, George Washington University

S8.18.1 Policy Implications for Virginia Initiative for Science Teaching and Achievement: Investing in Innovation (i3) Grant

Donna R. Sterling, George Mason University, dsterlin@gmu.edu

Wendy M. Frazier, George Mason University

Juanita Jo Matkins, College of William and Mary

Jacqueline T. McDonnough, Virginia Commonwealth University

Randy L. Bell, University of Virginia

ABSTRACT: This paper introduces Virginia Initiative for Science Teaching and Achievement (VISTA), which is a partnership among 47 school districts, six universities, and the Virginia Department of Education to build an infrastructure to provide sustained, intensive science teacher professional development to increase student performance. Funded by the United States Department of Education (Investing in Innovation Fund – i3), the goal of VISTA is to improve science teaching and student learning throughout Virginia especially in high-need (high-poverty, high minority) schools. In conjunction with validating prior efforts, the funded project has been designed to shape state- and local-level policy and practice in three areas: • Upper elementary (grades 4-6) teachers **Tuesday,**

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experience scientific, problem-based learning and student-centered inquiry as they work in teams to conduct inquiry-based science for children. • Uncertified or provisionally licensed secondary (grades 6-12) science teachers are provided just-in-time coaching and “big picture” research-based teaching coursework for two years. • VISTA builds state infrastructure for leadership and support needed to extend quality inquiry-based science teaching to LEP students, rural students, and students with disabilities. Discussed is the preparatory work that was required for this project in order to ensure that the project’s impact on policy at the state- and local-levels is maximized.

S8.18.2 Science Teacher Retention: Examining a Link between Deprofessionalization and Dissatisfaction for Teachers

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

Steve J. Oliver, University of Georgia

Deborah J. Tippins, University of Georgia

ABSTRACT: This article, based on an interpretive study of 11 science teachers from the rural, Black Belt region of Georgia, presents the personal, professional, and contextual tensions they faced as they made their career trajectory decisions. Although these teachers worked at schools considered “difficult-to-staff”, due to location, socioeconomics, and demographics, one school became stable and high achieving, a place where teachers stayed and students excelled. This study reached beyond reporting the general demographic trend data and explored the individual teachers at Wilson County High School. Wilson boasted an 89% graduation rate in 2009, which steadily increased from 50% in 2001. The results highlight the impact of contextual dimensions within the professional lives of teachers which affected the career trajectory of the science teachers. These educators felt that their vision of the teaching profession and changing professional responsibilities as teachers were in heightened conflict. Due to deprofessionalization as evidenced by lack of input into important school related matters, resource mismanagements, and standards and accountability implementation, two experienced teachers are now considering leaving. Implications of this research are twofold, and focus on the need to address the current reform emphasis on standardized assessment as well as suggestions for improving preservice education.

Equity and Ethics Committee Sponsored Session

S9.1 Poster Symposium - Moving the Equity Agenda Forward: Equity Research, Practice, and Policy in Science Education

4:00pm – 5:30pm, Antigua 3

Presiders:

Julie A. Bianchini, University of California, Santa Barbara

Valarie L. Akerson, Indiana University

Angela M. Calabrese-Barton, Michigan State University

Okhee Lee, University of Miami

Alberto J. Rodriguez, San Diego State University

Presenters:

George E. Deboer, American Association for the Advancement of Science

Sherry A. Southerland, Florida State University

Nancy W. Brickhouse, University of Delaware

Alejandro Gallaard

Sonya Martin

Beth Wassel

Kathryn Scantlebury, University of Delaware

Bhaskar Upadhyay, University of Minnesota

Gayle A. Buck, Indiana University

Leon Walls, University of Vermont

Cassie F. Quigley, Clemson University

Miyoun Lim

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Edna Tan

Bryan Brown

Emily J. Kang

Maria S. Rivera Malucci, Barnard College

Felicia Moore-Mensah, Columbia University

Gail Richmond, Michigan State University

Discussants:

Michael J. Reiss, University of London

Lyn C. Carter, Australian Catholic University

Tali Tal, Technion University in Israel

Mei Hung, National Taiwan Normal University

Melina Furman, University of San Andres

ABSTRACT: This symposium highlights current equity-related research, practice, and policy in science education and suggests important directions for future work. Presiders, presenters, and discussants in this symposium are contributors to an edited volume by the same name to be published later this year. Both the symposium and edited volume grew out of a NARST Equity and Ethics' ad hoc committee convened three years ago. The symposium will begin with a brief introduction to each of five areas of equity-related research: (1) Science Education Policy; (2) Globalization; (3) Language, Discourse, and Identity; (4) Context and Culture; and (5) Leadership and Social Networking. After introductory remarks, participants will be invited to read and discuss the research of contributing scholars displayed around the room on posters. To promote coherence, each set of authors will explain how their work informs the following two questions: (1) What insights do the theoretical and methodological lenses used in this scholarship enable and constrain? (2) What are ways ideas presented here can be used to inform research, practice, and policy? To close the symposium, five discussants, all international scholars in science education, will look across the research presented and discuss ways ideas introduced could inform science education work internationally.

Strand 1: Science Learning, Understanding and Conceptual Change

S9.3 Related Paper Set - Learning Progression for Carbon-transforming Processes in Socio-ecological Systems

4:00pm – 5:30pm, Curacao 1

Discussant: Joseph S. Krajcik, University of Michigan

ABSTRACT: The papers in this set report progress in developing a learning progression covering fourth grade through college students for carbon-transforming processes in socio-ecological systems at multiple scales, including cellular and organismal metabolism, ecosystem energetics and carbon cycling, carbon sequestration, and combustion of fossil fuels. The primary cause of global climate change is the current worldwide imbalance among these processes. Papers 1, 2, and 3 report on analyses of 140 clinical interviews conducted before and after teaching interventions during the 2008-9 and 2009-10 academic years. We have improved the quality of our descriptions of Levels of Achievement in the learning progression and provide evidence for consistency of student reasoning within accounts of carbon-transforming processes and between processes, as well as investigating students' arguments and use of informal discourse. Paper 4 evaluates the validity and reliability of written assessments administered to 4816 elementary, middle, high school and college students. Paper 5 investigates student learning gains, showing that the instructional interventions produced significant learning, and that learning varied according to choices and approaches of individual teachers.

S9.3.1 Cohesion and Consistency in Students' Accounts of Carbon-transforming Processes

Hui Jin, Ohio State University, jinhui2009@gmail.com

Charles W. Anderson, Michigan State University

S9.3.2 The Role of Informal Discourses in Students' Accounts of Carbon-transforming Processes

Hamin Baek, Michigan State University

Charles W. Anderson, Michigan State University

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S9.3.3 Argumentation in Students' Accounts of Carbon-transforming Processes

Onyancha Kennedy, Michigan State University
Charles W. Anderson, Michigan State University

S9.3.4 Developing Reliable and Valid Assessment Items to Assess K-12 Students' Learning Progression of Carbon Cycling

Jing Chen, Michigan State University
Yongsang Lee, University of California, Berkeley
Jinnie Choi, University of California, Berkeley
Karen Draney, University of California, Berkeley
Charles W. Anderson, Michigan State University

S9.3.5 The Effects of Teaching Materials and Teachers' Approaches on Student Learning about Carbon-transforming Processes

Li Zhan, Michigan State University
Dante Cisterna, Michigan State University
Jennifer Doherty, Michigan State University
Yongsang Lee, University of California, Berkeley
Karen Draney, University of California, Berkeley
Charles W. Anderson, Michigan State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S9.4 Students' Perceptions

4:00pm – 5:30pm, Curacao 2

S9.4.1 The Role of Emotional Factors in Building Public Scientific Literacy and Engagement with Science

Huann-Shyang Lin, National Sun Yat-sen University, huannlin@faculty.nsysu.edu.tw
Zuway-R Hong, National Sun Yat-sen University

ABSTRACT: This study uses the database from an extensive international study on 15-year-old students (N=8815) to analyze the relationship between emotional factors and students' scientific literacy and explore the potential link between the emotions of the students and subsequent public engagement with science. The results revealed that students' scientific literacy is significantly correlated with their interest, enjoyment, and engagement in science learning ($p < 0.001$). The groups of students with high levels of three emotional factors outperform their medium- and low-level counterparts in scientific literacy. Additional comparisons of emotions during science learning between these students and the adult population from another study indicate a number of similarities with the exception that the adults are more involved in learning science through television. It is suggested that improving the emotions that current students experience when learning science is more likely to enhance future public engagement in science-related issues.

S9.4.2 Linking Students' Conceptions of Learning Science with their Metacognition and Science Learning Achievement in Taiwan

Min-Hsien Lee, National Taiwan University of Science and Technology, mhlee@mail.ntust.edu.tw
Chin-Chung Tsai, National Taiwan University of Science and Technology
Chun-Yen Chang, National Taiwan Normal University

ABSTRACT: Researchers have attempted to investigate students' conceptions of learning science and suggested that students' conceptions of learning science have a potential impact on their meaningful learning. This study aimed to explore the relations between students' conceptions of learning science, their metacognitive awareness, and science learning achievement. Participants were 240 tenth graders in Taiwan and were administered the Conceptions of Learning Science questionnaire and Metacognitive Awareness regarding Science learning Inventory. Participants' final

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grades of science were collected as their learning achievement. The findings suggested that students with more metacognitive awareness regarding learning science tended to embrace more mature conceptions of learning science. In addition, students with lower metacognitive awareness tended to perceive learning science simply as to pass the examinations. The findings also indicated that both the conceptions of learning science and metacognitive awareness may have associations with science learning achievement. On the one hand, students with much more awareness for critically evaluate scientific information and who viewed learning science as the application of scientific knowledge tended to obtain higher learning achievement. On the other hand, students who viewed learning science as memorizing definitions or as a series of calculating and manipulating formulae tended to result in lower science achievement.

S9.4.3 Pupils' Perceptions About The Efficient School

Mónica Baptista, Instituto de Educação da Universidade de Lisboa, mlmbaptista@gmail.com

Ana M. Freire, Instituto de Educação da Universidade de Lisboa

ABSTRACT: In Portugal, the curriculum for teaching science in middle school gives emphasis to education for sustainability, mentioning the needs to pupils think about environmental, economic and social impacts of their actions, in order to facilitate more sustainable development. Taking it into account, in this study a science teacher uses inquiry with her pupils in order to promote education for sustainability. So, the present study aims at describing pupils' perceptions about inquiry activity concerning "the efficient school". The research reported is qualitative, adopting an interpretative orientation. Participants were ten pupils who attend the 12th grade of a professional education and training course to become electricians. Data analysis was inductive, consistent with a naturalistic research paradigm, and consisted of uncovering salient patterns, singularities, and themes associated with research aims. This study shows that is possible to develop inquiry activities in science classes that promote the education for sustainability and the professional development. The pupils became more sensitive to the need of managing energy consumption in a sustainable way, and to its environmental, societal and economic impact.

S9.4.4 A Structural Model of High School Students' Conceptions of Learning Science, Approaches to Learning Science and their Science Self-Efficacy

Guo-Li Chiou, National Chiao Tung University, Taiwan, glchiou@mail.nctu.edu.tw

Jyh-Chong Liang, National Taiwan University of Science and Technology, Taiwan

Min-Hsien Lee, National Taiwan University of Science and Technology, Taiwan

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

ABSTRACT: This study proposes a structural model to delineate the relationships between students' conceptions of learning science, approaches to learning science and their science self-efficacy. Three questionnaires, Conceptions of Learning Science (CLS), Approaches to Learning Science (ALS) and Science Self-Efficacy (SSE), were administered to 321 Taiwan high school students. The results of structural equation modeling (SEM) confirmed our hypothesis that students' conceptions of learning science had a direct effect on their approaches to learning science which in turn contributed to their science self-efficacy. More specifically, the students' lower-level conceptions of learning science, memorizing, testing and calculating and practicing, exercised positive effects on their surface approaches to learning science, but had negative effects on their deep approaches to learning science. In contrast, students' higher-level conceptions of learning science, increasing one's knowledge, applying, understanding and seeing in a new way, could positively induce the deep motive, deep strategy and surface motive to learn science, but prohibited the surface strategy. In sequence, the students' deep motive, deep strategy and surface motive were likely to make direct contributions to their science self-efficacy.

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

S9.5 Strategies that Promote Student Learning

4:00pm – 5:30pm, Curacao 4

Presider: Mehmet Aydeniz, The University of Tennessee

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S9.5.1 The Evolution of Classroom Physics Knowledge in Relation to Certainty and Uncertainty

Andree Tiberghien, UMR ICAR, France, andree.tiberghien@univ-lyon2.fr

David Cross, UMR ICAR, France

Gérard Sensevy, University of Bretagne Occidentale, France

ABSTRACT: We propose to characterize the evolution of knowledge involved in two grade 10 physics classrooms in relationship to the certainty and uncertainty of two different elements of physics knowledge—one specific and one general. The first element of knowledge studied is related to students' difficulty and the certainty of that knowledge based on physics interpretation of material situations in terms of action; and the second concerns the principle of Inertia of which certainty is mainly established by the physics community. Our study falls within the theory of joint action in Didactics (Sensevy, 2007). We present an analysis of two physics classrooms during a teaching sequence of 7 sessions in Mechanics, which were videotaped. From these video data we select episodes dealing with the two elements of knowledge involved in several sessions. The results of our study show changes of status of these elements of knowledge during the teaching sequence, in accordance with the responsibility the teacher or the students have in reaching certainty (or not reaching certainty) vis-à-vis elements of knowledge. This study contributes by making explicit the role of teacher and student justifications in Physics as well as to improve teachers' professional development.

S9.5.2 Illuminating the Relationship between Inquiry Science Instruction and Student Learning: Results from Three Case Studies

Jacqueline R. Delisi, Education Development Center, Inc., jdelisi@edc.org

Katherine L. Mcneill, Boston College

Daphne D. Minner, Education Development Center, Inc

ABSTRACT: There is widespread agreement about the impact that teachers can have on student learning, yet the mechanisms and strategies that teachers employ remain unclear. This paper provides results from case studies of three teachers implementing an inquiry-based urban ecology curriculum. The study uses a new comprehensive observational tool to explore the nuances of teacher practice, including the nature of teachers' verbal practices and the types of activities teachers use. Results indicate that the teachers with the greatest gains in student learning employed the greatest frequencies of higher order questioning techniques to actively engage students. The analysis highlights potential connections between instructional strategies and student learning and has implications for larger quantitative studies of teacher practice.

S9.5.3 The Effectiveness of Epistemologically and Metacognitively Stimulated Learning Cycle Method on 10th Grade Students' Physics Achievement

Sevda Yerdelen-Damar, yerdelen@metu.edu.tr

Ali Eryilmaz

ABSTRACT: The present study was carried out to investigate the effect of epistemologically and metacognitively stimulated learning cycle method on 10th grade public high school students' achievement in force and motion unit. Participants of the study were 105 tenth grade students (48 females, 57 males) from four intact classes of two public high schools. The classes were randomly assigned into experimental and control groups. The experimental group was instructed with epistemologically and metacognitively stimulated learning cycle method whereas the control group was instructed by the traditional method. Force and Motion Achievement Test (FMAT) was applied as pretest to measure students' pre-knowledge about force and motion concepts. The same test was also administered as posttest to compare achievement level of experimental and control group students. ANCOVA with pre- FMAT scores used as a covariate was employed to compare the effectiveness of the instruction based on epistemologically and metacognitively stimulated 7E learning cycle and traditional instruction. The findings indicated that the students instructed with epistemologically and metacognitively stimulated learning cycle method had better understanding than those taught with traditional physics instruction. The findings of the study also showed that there was a significant relationship between students' pre-test scores and post-test scores on FMAT.

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S9.5.4 The Role of Science Writing Heuristic Approach on Students' Conceptual Understanding in Chemistry

Sevgi Kingir, Selcuk University, kingirsevgi@gmail.com

Omer Geban, Middle East Technical University

Murat Gunel, Ahi Evran University

ABSTRACT: The present study was conducted to compare the effectiveness of science writing heuristic (SWH) and traditional approach on ninth grade students' conceptual understanding in chemistry. 122 students of two teachers in a public high school participated in this study. Each teacher's one class was assigned as experimental group, and the other class was assigned as control group. Students in the experimental groups were instructed by SWH approach while students in the control groups were instructed by traditional approach. Chemical Changes and Mixtures Concept Test was administered to both groups as a pretest to determine group differences prior to the study, and a posttest to understand the effectiveness of treatment on students' conceptual understanding. After the treatment, semi-structured interviews were conducted with 21 students for the purpose of understanding students' ideas about the usage of SWH approach and their conceptual understanding in chemistry. The statistical results revealed that students instructed by SWH approach scored significantly higher than those instructed by traditional approach on posttest. In addition, interview results indicated that students in experimental groups found SWH approach more effective than traditional approach. Moreover, students in SWH groups developed more scientific understanding of chemistry concepts compared to those in control groups.

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

S9.6 Influencing Students' Reasoning & Development of Expertise

4:00pm – 5:30pm, Curacao 5

President: Taha Mzoughi, Kennesaw State University

S9.6.1 Investigating the Effects of Solving Synthesis Problems in Introductory Physics Courses

Lin Ding, School of Teaching and Learning, The Ohio State University, ding.65@osu.edu

ABSTRACT: Base on the framework of domain specificity and effective heuristics of problem solving, we investigated how using synthesis problems may help cultivate students' ability to seek and apply fundamental principles for tackling physics problems, an approach consistently employed by experts. Synthesis problems are designed to combine concepts that are broadly separated in the teaching timeline, circumventing the "locality" disadvantage of many traditional textbook exercises that address only topics covered in single chapters. To facilitate students' attention to underlying concepts, we used scaffolding in the format of concept questions prior to students' solving each synthesis problem. These concept questions contain individual topics that are synthesized in the subsequent problem. In a study, three groups of students received 3 different types of training for 2 weeks. One group was trained with scaffolding plus synthesis problems; another solved synthesis problems only; the last used textbook-like single-concept problems. Four days after the training, a common final examination including a synthesis problem was administered to all students. Analysis of students' solutions indicated the best performance for those who received scaffolded synthesis problems, followed by those who used synthesis problems only.

S9.6.2 Physics as a Community of Practice: A Qualitative Interview Study of Three University Physics Professors

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Eric Brewe, Florida International University

Laird H. Kramer, Florida International University

ABSTRACT: Research on physics expertise has mostly focused on the cognitive differences between physics experts and novices. In these studies the experts are declared to be the university physics professors or graduate doctoral students without justification. Taking the perspective that learning is the transformation of participation within a community of practice (Lave and Wenger, 1991) we view physics professors as having transformed their participation from students, to teachers, to mentors and therefore are considered physics experts. To understand more about not only being a physics expert but also how to become one, we conducted a qualitative interview study of three university physics professors.

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Each professor had an hour-long interview where they were asked about their experiences of becoming a physics expert and characterizing physics expertise. Analysis of the data resulted in the construction of a model of physics expertise, where faculty view building physics expertise as moving through stages, developing knowledge skills, and adopting the norms of the community. They also view physics experts as first being specific physics experts, which acquire general physics expert characteristics and then becomes an expert in physics or a boundary crosser.

S9.6.3 Effects of Visual Attentional Cueing on Beginner Problem Solvers in Physics

Tanner Stevens, University of Minnesota, steve461@umn.edu

Adrian Carmichael, Kansas State University

Adam Larson, Kansas State University

Elizabeth Gire, University of Memphis

Lester Loschky, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: Previous research suggests that manipulating learners' eye movements may affect cognitive processing. This study builds on a previous study by investigating problems that were found to have large differences in eye-movements between beginner problem solvers and expert problem solvers. In this study, beginner physics problem solvers were asked to solve problems with highly visual components, adapted from our previous study. If students gave an incorrect answer and/or verbal explanation for their answer, they were shown scaffolding problems. In each scaffolding problem, students were either cued or not cued to look at colored shapes as they moved across the screen. Cues were designed to direct attention to relevant areas of the problem. After a given number of problems, students were shown a transfer problem relating to the first problem in each problem set. After each problem, students were asked to give a verbal explanation of their answer. We found that students performed better on later problem sets after receiving cueing, a larger number of students answered with correct explanations before the transfer problem in the cued group, and students who received cueing changed their explanations more often. Future work is needed to test these ideas for larger numbers of students.

S9.6.4 Scientific Reasoning and Conceptual Knowledge in a College Inquiry Physics Course

Omer Acar, Kocaeli University, acarok@gmail.com

Bruce R. Patton, Ohio State University

ABSTRACT: A line of research in science education examined student reasoning skills and conceptual knowledge in inquiry classes. Conceptual knowledge was treated as representing a unidimensional construct in these studies. However research on conceptual knowledge show that this construct may consist of several hierarchical levels. Thus examination of students with different reasoning abilities performance on different levels of hierarchical conceptual levels would provide a better picture of what is happening in the classroom. This research examined and compared the development of declarative and situational conceptual knowledge of concrete, formal, and post-formal reasoners. Results indicate that situational knowledge gains, which is a higher hierarchical conceptual level, from pretest to the posttest were similar to declarative knowledge gains. In addition, it was found that post-formal and concrete reasoners' gains were not different from each other.

Strand 6: Science Learning in Informal Contexts

S9.7 Science Under the Stars: Insights from Science Camps

4:00pm – 5:30pm, Curacao 6

S9.7.1 The Role of Informal Science Program on Middle School Students' Perceptions of Science and Engineering

Pat Dixon, National High Magnetic Field Laboratory, pdixon@magnet.fsu.edu

Roxanne Hughes, Florida State University/National High Magnetic Field Laboratory

Kristen Molyneaux, University of Wisconsin, Madison

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ABSTRACT: This study compares two informal science learning environments on middle school participants' science identity formation. This formation is often affected by the stereotype of science as male and white. The informal science learning environments in this study exposed participants to science professionals and their daily activities. This exposure allowed students to see the community of practice of science and to try on the identity inherent within. The results indicate that the single gender camp resulted in positive significant changes in students' perceptions of scientists compared to the co-educational camp.

S9.7.2 Lessons Learned in Summer Camp: Learning Paths of Three Campers

Lauren Madden, North Carolina State University, LOMadden@gmail.com

John C. Bedward, North Carolina State University

Eric N. Wiebe, North Carolina State University

Claudia R. Benitez-Nelson, University of South Carolina

ABSTRACT: Science camps provide opportunities to expose students to topics not typically covered in the classroom, such as marine science. This multi-case study examines learning paths for three campers enrolled in Ocean Explorers, a marine science camp for elementary age children. Interviews, knowledge inventories, and science notebook analyses were triangulated and resulted in narrative learning path descriptions. We found: 1) each camper followed a unique learning trajectory throughout camp; 2) campers' learning was socially constructed; and 3) the campers each preferred concrete representations of phenomena over abstraction. These findings suggest Ocean Explorers is an effective mechanism for increasing elementary students' understanding of marine science.

S9.7.3 Middle School Students' Identity Development as Learners of Science at an Informal Science Education Camp

Kelly Riedinger, University of Maryland, College Park, krieding@umd.edu

ABSTRACT: This study investigated middle school students' identity development as learners of science during learning conversations at an informal science education camp. I used an exploratory case study methodology for data collection and analysis to gain insight into the following research question: What is the role of conversation in influencing science learner identity development during an informal science education camp? Participants in the study were middle school students visiting the [name removed] with their schools for the [name removed] field trip program. Data collection included pre-post focus group interviews with students, pre-post interviews with classroom teachers, videotaped observations of science camp learning activities, students' responses to reflective journal prompts, and researcher field notes. Data analysis included discourse analysis and analytical induction to code for prominent themes. The unique characteristics of the informal science camp program influenced group identity development as learners of science. At the informal science education camp, group members learned more about one another, came to see themselves and others as capable learners of science, learned to collaborate with others, and participated more equitably during group work. This study has implications for those involved with informal education program and exhibit development.

Strand 7: Pre-service Science Teacher Education

S9.8 Preservice Teachers' Developing Science Teaching Practice

4:00pm – 5:30pm, Curacao 7

President: Yovita N. Gwekwerere, Laurentian university

S9.8.1 Examining the Content and Nature of Preservice Teachers' Early Field Experiences: A Schematic Framework Approach

Karthigeyan Subramaniam, University of North Texas, Karthigeyan.Subramaniam@unt.edu

ABSTRACT: This paper describes an exploratory study that examined the content and nature of the schematic frameworks that preservice elementary teachers construct when they individually and collaboratively reflected on their documented early field experiences during their science methods field experience. Data sources included documented early field experiences, individual reflective journal entries, and synthesis papers. A thematic analysis approach to data revealed that the content of schematic frameworks resulting from participants' individual reflections were superficial

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descriptions of teachers' roles and teaching science as a scaffolded activity, while the content of schematic frameworks from collaborative reflections were also centered on teachers' roles and teaching science as a scaffolded activity but included details like why the teacher acted as a guide or mediator, and the roles of students and the science content in shaping these teachers' roles. Implications include (1) the need to provide sufficient theoretical support for preservice teachers to properly place their observations and reflective thinking in context; (2) the need to understand the educational significance of using structured and focused formats, and clear objectives for early field experiences; and (3) the importance of examining the schematic frameworks preservice teachers construct in early field experiences before they transition to late field experiences.

S9.8.2 A Long Term Investigation of Science Teacher Resilience

Patricia A. Doney, University of Georgia, patdoney@uga.edu

ABSTRACT: The purpose of this study was to investigate factors that influenced resilience building in four novice high school science teachers. This study focused on components that enabled teachers to cope successfully with challenges and stress during their initial years of teaching. The participants were four novice high school science teachers recently graduated from a southeastern university. Data took the form of in-depth, semi-structured interviews, job shadowing, relational mapping, written prompts, and classroom observations. Each teacher was treated as an individual case and data from each case were analyzed using an inductive approach. Analysis of data revealed that novice teacher resilience occurs as a result of interactions between the individual and their context and include their individual identities, the contextual landscape in which they work and their ability to employ factors that enable them to overcome adversity. Understanding the role of resilience in secondary science teachers adds to existing knowledge on the importance of resilience training for pre-service teachers and those in their initial years of teaching. This research further suggests that some time-tested advice offered by secondary science teacher educators may need to adjust to the realities existing in the field.

S9.8.3 Using Third Generation of Cultural-Historical Activity Theory (CHAT) as a Data Analysis Framework to Explain Novice Teachers' Learning to Teach Science

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

Asli Sezen, The Pennsylvania State University

Scott P. McDonald, The Pennsylvania State University

Gregory J. Kelly, The Pennsylvania State University

ABSTRACT: The study draws from cultural-historical-activity-theory (CHAT) and sociolinguistics to analyze how pre-service teachers' reflective practices are related to their actual teaching practices in a micro-teaching activity. The study was conducted with 23 pre-service teachers enrolled in a secondary science teaching methods course at a university's teacher education program. During this course, pre-service teachers' engaged in micro-teaching of 4-5 middle school students. These events were videotaped, and the teachers subsequently provided voice-over reflections on a second audio track of videotapes. Talks and actions of both microteaching activity and voice-over reflections were transcribed and each line of the transcripts were coded by using the third generation of CHAT framework (Engestrom, 1999), revised for the micro-teaching activity and reflective activity of the pre-service teachers attended to our study. Our preliminary analyses revealed differences (e.g. division of labor between pre-service teachers and students) and similarities (e.g. mediating artifacts used during the teaching activity: computer software, instructional plan, and etc.) around what novices attend to in their practices vs. reflection. As we continue our analyses, the results show the potential of CHAT to contribute to the understanding of the discourse of learning to teach and how novice teachers make sense of their initial teaching practices.

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Strand 7: Pre-service Science Teacher Education

S9.9 Related Paper Set - Promoting Effective Science Teaching for English Learners: Testing a Model of Pre-Service Teacher Training

4:00pm – 5:30pm, Bonaire 7

Discussant: Okhee Lee, University of Miami

ABSTRACT: This session presents four papers on research and practice for improving the teaching and learning of science for English learners (ELs). Researchers utilized a socio-cultural framework to develop an intervention within three teacher education programs then gauged pre-service teacher dispositions and practices with respect to the effective ELs pedagogy that was a part of the intervention. Specifically, the four papers presented include: (1) a framework grounded in socio-cultural theory and empirical evidence for six practices that promote science learning among ELs; (2) a description of the development process of a science teacher education methods course designed to prepare elementary teachers to teach science to ELs; (3) a description and evaluation of the professional development delivered to cooperating teachers that served as mentors to the pre-service teachers during their clinical experience; and (4) the results of an empirical study that examined the development of the knowledge, beliefs and practice of elementary pre-service teachers for teaching science to ELs.

S9.9.1 Empirical Foundations of ESTELL Pedagogy with Exemplars of Practice

Jerome Shaw, University of California, Santa Cruz

S9.9.2 Meaningful Collaboration: Establishing a Science Methods Course with a Focus on English Learners in Three Different Universities

Alberto Rodriguez, San Diego State University

Meredith Houle, San Diego State University

Isabel N. Quita, San Francisco State University

Alie Victorine, San Jose State University

S9.9.3 ESTELL Professional Development

Cathy Zozakiewicz, San Diego State University

Sara Tolbert, University of California Santa Cruz

S9.9.4 Pre-Service Teacher Efficacy and Practices with Responsive Science Pedagogy for English Learners

Marco A. Bravo, Santa Clara University

Jorge L. Solís, University of California Santa Cruz

Eduardo Mosqueda, University of California Santa Cruz

Strand 8: In-service Science Teacher Education

S9.10 Impacting Teacher Practice

4:00pm – 5:30pm, Curacao 8

President: Bongani D. Bantwini, Kennesaw State University

S9.10.1 Teachers-as-Learners: Characterizing the Relations between Theory and Practice through Teachers' Questions

Shaharabani Yael Furman, Weizmann Institute of Science, yaelfsha@gmail.com

Anat Yarden, Weizmann Institute of Science - Department of Science Teaching

ABSTRACT: Many teachers relate to theory as irrelevant or far from their everyday lives, and thus the gap between theory and practice is a well-known barrier to education improvement. Questions raised by teachers during their learning process, termed here teachers-as-learners' questions, have the potential to serve as probes towards gaining a better understanding of their perspective on practice, theory and the relations between them. Our research objective was to characterize teachers-as-learners' questions as a tool to probe the ways in which teachers relate practice and

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theory. We employed a grounded theory approach to study the questions of 21 biology teachers participating in a special graduate program intended to empower science teachers. Here we report on the development of a framework for analyzing teachers' questions raised during a course "Learning and teaching in biology" that was based on a "Theory and Practice" approach. Four distinct categories of teachers-as-learners' questions regarding theory and practice were identified. Most questions attempted to form relations between practice and theory, and emphasized the complex practical knowledge teachers have. This research demonstrates that teachers can combine theory and practice in their questions, which may serve as markers of their thinking. The implications and possible contribution are discussed.

S9.10.2 Factors Affecting District Officials' Capacity to Provide Effective Support in the Implementation of Natural Science Curriculum Reforms in South Africa

Bongani D. Bantwini, Kennesaw State University, bbantwin@kennesaw.edu

ABSTRACT: The influential role of school districts as the legal and fiscal agents that oversee and guide school and improve their quality of teaching and learning is unavoidable. District officials play a key function in the local implementation of new reforms. Through perspective analyses, this paper explores the conditions that affect district capacity to provide effective support in the implementation of natural science reforms in a district in South Africa. Finding shows that the relationship between the district officials and teachers, district officials workload versus what is feasible, school reality issues, are likely to determine the success or failure of curriculum reforms. To heed such challenges as they have gravity to nullify the efforts to improve the school conditions and student performances is indispensable. In conclusion, ways to bridge the gap between theory and practice and strategies to promote partnership between district officials and schools are proposed.

S9.10.3 Smarter Science: A Framework for Implementing Inquiry in the Science and Technology Classroom

Maurice Diguiseppe, University of Ontario Institute of Technology, maurice.diguiseppe@uoit.ca

Isha Decoito, York University

Xavier E. Fazio, Brock University

ABSTRACT: Teaching in ways consistent with scientific inquiry requires science teachers to become immersed in opportunities to develop teaching-learning activities that address scientific inquiry in the classroom. One such opportunity is through an initiative called Smarter Science© which offers teachers and students a structured approach to developing science inquiry activities for the science classroom. To determine the impact of this initiative on teaching and learning science, we are conducting a longitudinal study involving students, teachers, administrators, and workshop leaders from schools across the province that participate or have participated in Smarter Science workshops. This paper reports on survey data exploring participants' understandings of scientific inquiry and its role in science teaching prior to their engagement in a Smarter Science© institute on inquiry. Results show that most teachers possess varying understandings of scientific inquiry, while relying on the scientific method to illustrate student driven inquiry. They all agreed that scientific inquiry is an essential component of effective science teaching and that the institute was instrumental in supporting their decision to implement inquiry in their science classrooms. These findings have implications for practice and theory as they highlight the important role of effective professional development in supporting teachers to engage in inquiry-oriented science teaching.

Strand 10: Curriculum, Evaluation, and Assessment

S9.11 Socioscientific Issues and the Nature of Science

4:00pm – 5:30pm, Bonaire 1

S9.11.1 Non-Science Majors Perceptions of Integrating SSI Instruction into High School Curricula

John C. Parr, University of Southern Mississippi, john.parr@eagles.usm.edu

Nasser Syed, University of Southern Mississippi

Kristy L. Halverson, University of Southern Mississippi

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ABSTRACT: This study explores the feelings of recent high school graduates concerning the inclusion of selected socioscientific issues in secondary classrooms. We selected evolution, stem cell research, and climate changes as the potentially controversial topics we would explore. Forty-two undergraduate, non-science majors completed two questionnaires and four key informants participated in semi-structured interviews. A qualitative approach was used to examine the results and produce findings in the form of vivid descriptions. Participants were generally willing to accept the inclusions of these topics, but did not see this as support for a single scientific belief. Participants rarely espoused the benefits of a decision making process based on empirical evidence, and expressed a desire for the inclusion of multiple explanations. Respondents articulated that students should be free to reach independent conclusions and that conflict should be avoided. Numerous respondents expressed a lack of experiences in school with one or more of the socioscientific issues we examined. This void left family, peers, and social media as the primary factors used in reaching conclusions. Our results demonstrate a need for secondary schools to emphasize the role of empirical evidence while expanding their coverage of socioscientific issues.

S9.11.2 Quantifying Informal Science Educators' Beliefs about Pesticide Risk: Development of the Pesticide Risk Belief Inventory

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

Margaret R. Blanchard, North Carolina State University

Julia F. Storm, North Carolina State University

Gregory Cope, North Carolina State University

ABSTRACT: Recent national attention to the risks that agricultural pesticides pose to the environment and human health presents an opportunity for science educators to enhance public understanding of basic toxicology and environmental science concepts; little is known, however, about what misconceptions and knowledge gaps may exist among the general public. This study highlights the development of a quantitative questionnaire of pesticide risk beliefs to be used to develop communications and curricular materials that address the target audience's prior knowledge and beliefs related to pesticides. The Pesticide Risk Belief Inventory was created and tested with one potential target audience, pesticide educators. The 20-item, Likert-type inventory was found to be psychometrically sound with a coefficient alpha of 0.800 and to be a valuable tool in capturing the beliefs of informal science educators for pre-assessment of pesticide and toxicology misconceptions and knowledge gaps. In addition to its uses with individuals at risk in agricultural settings or informal pesticide educators who work with these farmworkers, the Pesticide Risk Belief Inventory may be utilized by science educators to explore beliefs about pesticide risks held by secondary science and college students, science teachers and professors, science education professors, and the general public.

S9.11.3 Towards Critical and Emancipatory Science & Technology Education: A Theoretical Framework

John L. Bencze, OISE, University of Toronto, larry.bencze@utoronto.ca

Steven J. Alsop, Faculty of Education, York University, Toronto

Erin Sperling, OISE, University of Toronto

ABSTRACT: Given the potential seriousness of 'socioscientific' issues (SSIs), such as potential Climate Change and illnesses resulting from food additives, many jurisdictions have urged educators to engage students in decision making regarding these sorts of issues. Scholars and others argue, however, that students also need to take sociopolitical actions — such as lobbying of power-brokers — to address SSIs. In this largely paper, we provide a theoretical framework for such an activist science and technology education. We claim that this framework synthesizes research and pedagogy associated with prominent fields of science education studies — including those focusing on socioscientific issues, the nature of science, science inquiry and the 'engaged' program of science and technology studies. Implications of theory and practice are discussed.

S9.11.4 Assessing Understanding about Nature of Science in Historical Contexts

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Gary M. Holliday, Illinois Institute of Technology

Hans E. Fischer, University of Duisburg-Essen

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Alexander Kauertz, University of Education - Pädagogische Hochschule Weingarten

Judith S. Lederman, Illinois Institute of Technology

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Within science education research, Nature of Science (NOS) and Nature of Scientific Inquiry (NOSI) are agreed on as important topics for science education. Mainly due to international large-scale assessments, e.g. Programme for International Student Assessment (PISA), recent science education research has focused on teaching and testing for competences. While various valuable questionnaires do exist that investigate students' understandings of 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 three-dimensional model of competence regarding NOS and NOSI. Test items were developed based on physics history contexts. These items were administered to 1080 10th graders of all levels of school performance using a multi-matrix design. Rasch modeling was employed for data analysis. ANOVA revealed insights in construct validity. Correlation analyses concerning competence-related constructs provided insights in criterion validity. Results show that the developed items might be a first step to providing a workable competence test for NOS and NOSI.

Strand 12: Educational Technology

S9.12 Technology Instruction and Implementation Across Contexts

4:00pm – 5:30pm, Bonaire 3

Presider: Rooy Wilhelmina S. Van, Macquarie University

S9.12.1 Student Perceptions of Learning and Engagement with Scientific Concepts through Serious Educational Game (SEG) Development

Brandi Thurmond, North Carolina State University, bnthurmo@ncsu.edu

Shawn Y. Holmes, North Carolina State University

Leonard A. Annetta, George Mason University

Elizabeth Folta, SUNY-ESF

Matthew Sears, Hillside New Tech High School

Rebecca Cheng, George Mason University

Brandy Bowling, North Carolina University

ABSTRACT: Serious Educational Games (SEGs) are on the rise and several psychological and educational theories have been utilized by researchers to justify why educators should invest time and energy to incorporate SEGs into teaching environments. This investigation was part of a larger project involving two phases: (1) teacher creation of SEGs and (2) student creation of SEGs. Over two-years, teachers participated in professional development to create SEGs situated in standard-based science and math curriculum. During the third year, students began developing their own SEGs based on science topics they had researched. At the end of the workshop, interviews were conducted with selected students who had participated in both phase one and two of the project (Group A) and students who had participated only in phase two (Group B) to answer the following research questions: 1. How did student participation in first phase of the project affect the development of their SEG in the second phase? 2. What are student perceptions toward their learning of and engagement with scientific concepts through research and SEG development? A qualitative methodology was utilized to analyze interview data, in which emergent themes and similarities and differences between participant responses were identified. Although Group A students, who had participated in both phases were better prepared to create their own SEG, both groups of students indicated that creating SEGs helped them learn science concepts more than just merely playing SEGs. Our research into the ability of SEGs to teach and engage students with scientific concepts revealed that students believed games made the learning of science concepts fun and interesting and that it was a useful tool that teachers could use to engage and entertain students.

S9.12.2 Models of Instruction for Technology-enhanced Whole-class Inquiry

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

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Bridget K. Mulvey, University of Virginia

Randy L. Bell, University of Virginia

ABSTRACT: This investigation provides detailed descriptions of participants' use of technology-enhanced whole-class inquiry instruction with the goal of developing instructional models that can inform science teacher preparation programs. Fifteen participants enrolled in a two-year Master of Teaching program were purposively selected from previous investigations based on their use of projected computer resources to implement whole-class inquiry instruction. One explicit goal of the program was to prepare science teachers to use digital technologies to support inquiry instruction using readily available technologies. A variety of data sources were used to characterize the participants' instructional practices with technology including classroom observations, lesson plans, interviews, and written reflections. Data analysis followed an analytic induction process and sought to characterize and profile how participants used various technologies to support whole-class inquiry instruction. Results indicated that participants used a variety of technologies including digital images, video, simulations, and animations to facilitate whole-class inquiry experiences for students. Profiles of use included observational investigations and experimental investigations. These profiles of participants' use of technology for whole-class inquiry instruction were developed into formal models of instruction that have the potential to inform how science educators support preservice teachers' use of technology for whole-class inquiry experiences.

S9.12.3 Metric or English Spatial Scales?: An International Comparison of Teachers Concepts

M. Gail Jones, North Carolina State University, Gail_Jones@ncsu.edu

Manuela Paechter, University of Graz

Grant E. Gardner, East Carolina University

Chiung-Fen Yen, Providence University

Amy Taylor, University of North Carolina at Wilmington

Thomas R. Tretter, University of Louisville

ABSTRACT: Scale is an important concept taught as part of science curricula across different countries. This study explored scale concepts of inservice and preservice teachers from three countries, Austria, Taiwan, and the United States. Accuracy of scale concepts differed in the samples of the three countries. The Austrian and Taiwanese teachers held significantly more accurate concepts of scale than the U.S. teachers for both large and small scales. In all countries, inservice teachers had more accurate concepts of large scales than preservice teachers. Taiwanese experienced teacher participants were more likely to report learning size and scale through in-school experiences than the Austrian or the US participants.

S9.12.4 A Review of the Research on Successful Implementation of Technology to Teach Science

Rebecca M. Krall, University of Kentucky, rebecca.krall@uky.edu

David A. Slykhuis, James Madison University

ABSTRACT: In this review of recent literature on the use of technology to teach science content, 143 articles from eight science education journals were selected and analyzed for the use of technologies in teaching science, pedagogies employed, and successes of the implementations. The resultant data provide a snapshot on how technology is being used in the teaching and learning of science, and the research methods used to explore these issues. Levels of research and levels of success were developed and applied to the data analysis to characterize the types of research and technology implementations described in the literature. The review underscores the research trend toward using technology to illustrate abstract concepts. Implications for successful use of technology to teach science are discussed.

Strand 13: History, Philosophy, and Sociology of Science

S9.13 History and the Science Curriculum

4:00pm – 5:30pm, Bonaire 4

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

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S9.13.1 The Preparation Process of Historical Materials Depending on the New Turkish Biology Curriculum

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Serhat Irez, Marmara University, Turkey

Hayati Seker, Marmara University, Turkey

ABSTRACT: The perpetual changes of social structure and progress in The perpetual changes of social structure and progress in technology forces changes in education. Due to this reason, there are reform marks in advanced and advancing countries' educational systems. Traditional methods disappear with up to date modern methods. Science education is affected by this process and strategies parallel to new approach have been created instead of traditional education formed as the transfer of the existing knowledge. Active usage of history of science for science education has a significant role. This study is a part of the national project that aims to wide and easy use of HOS in high school science education lessons. A facilitator model with four levels on the use of history of science in science teaching (Seker, 2007) was used as framework for the project. Within the scope of this study, the first step of the project is to conduct comparative content analysis to determine obstacles to the integration of history of biology into biology curriculum. In this context, this study explains the process of the preparation of the biological history materials, the approach use in this process and the problems noticed during this project considering the vision and benefits of the new curriculum.

S9.13.2 A Role for Science Education in the International Community: Exhibiting the Scientific Roots of the European Enlightenment

Michael R. Matthews, School of Education, University of New South Wales, m.matthews@unsw.edu.au

ABSTRACT: Abstract: A common feature of contemporary science education curricula is the expectation that as well as learning science content, students will learn something about science – its nature, its history, and its interactions with culture and society. This paper will discuss an important aspect of science's contribution to culture, namely its role in the formation of the European Enlightenment, and its continued support for and interdependence on this tradition of philosophical, religious, political and social thought. It was the new method of 17th century science that bore the hopes of the Enlightenment for progress in understanding across the whole spectrum of human affairs. Methodological changes how people went about assessing knowledge claims were not the only thing initiated by the Scientific Revolution: the new science (natural philosophy) also caused a massive change in Western philosophy that had enduring repercussions for religion, ethics, politics and culture. The Enlightenment was part of this philosophical change. By utilising Pope Pius IX's Syllabus of Errors (1864) encyclical, Ten Core principles of Enlightenment Ideology are delineated and defended.

S9.13.3 A Content Analysis of Historical Information Aligned With Physics Curriculum

Burcu G. Guney, burcugulay.guney@yahoo.com

Hayati Seker

ABSTRACT: History of Science (HOS) is assumed to be a potential resource for instructional materials, but teachers don't tend to use historical materials in their lessons. Studies showed that instructional materials should be flexible and suited to the objectives of existing curriculum. This paper purports to examine the appropriateness of HOS to the physics curriculum in the light of a facilitator model on the use of HOS in science teaching, and to expose possible difficulties in preparing historical materials. For this purpose, qualitative content analysis method was employed to examine the alignment between resources for HOS and physics curriculum. Codes and themes were defined beforehand, with respect to levels and their sublevels of the model. Then, gathered historical information was grouped under the levels and the sublevels. Through the analysis of HOS, problems to the use of HOS in existing physics curriculum were elucidated. Based on the findings of the analysis, it can be seen that HOS can provide a rich context for science teaching, but curriculum put boundaries to enact historical materials in practice. Following findings of this study, educators may work on historical materials that consider practicalities of enactment in science lessons.

S9.13.4 Constructing Historical Instructional Materials: The Case for Secondary Level Chemistry Curriculum in Turkey

Serhad S. Barutcuoglu, Marmara University, serhat1983@gmail.com

Ajda Kahveci, Canakkale Onsekiz Mart University

Tuesday, April 5, 2011

Hayati Seker, Marmara University

ABSTRACT: History of science (HOS) is considered as a potential resource for instructional material development; however some aspects of the main components of education, such as curricula and teachers themselves, give rise to obstacles in the use of HOS in science teaching. Thus, classroom realities should be considered in the development of instructional materials. This study is a part of a national project in Turkey on the use of history of science in science education. A HOS facilitator model with four levels was used as theoretical framework. The purpose of this paper is to examine the compatibility of HOS, history of chemistry in particular, with the chemistry curriculum in the light of the model, and to expose possible difficulties in constructing instructional materials aligned with pedagogical approaches. The focus was on two units selected from the 9th and 10th grade chemistry curricula. Qualitative content analysis was utilized to analyze the relation between history of chemistry knowledge and the curricula. Findings suggest that HOS provides a rich context and content for science teachers but there are difficulties to present the historical information. Studies that bring together teachers, historians of science and curriculum makers can reduce problems.

Strand 14: Environmental Education

S9.14 Related Paper Set - Innovative Teaching and Learning in Environmental Issues: An Emphasis on Thinking about Complexity

4:00pm – 5:30pm, Bonaire 5

ABSTRACT: Research has suggested the need for exploring the process of environmental learning. These related papers aimed to know how students deal with the complexity involved in environmental issues and to seek for teaching models that may effectively engage students in the democratic process in shaping and managing their own environment. Several different controversial environmental issues were integrated into science or environmental education courses. Assessments were designed to explore students' ability of higher order thinking, effective communications, and democratic debates. The first paper presents a course design that is based on the soft systems methodology and reflexive approach to teach college students about environmental issues. The second paper discusses an intervention task in a course that was modified from a procedure of strategic environmental assessment, and analyzes students' problem framing strategies as an account of active participation on environmental debates. The third paper was focused on the assessment of systems thinking ability, while the fourth and fifth papers were on argumentation skills in some teaching activities and reading strategy exploration involving environmental issues.

S9.14.1 Theoretical Foundations and Applications of an Action-oriented Learning Cycle for Teaching Environmental Issues

Shiang-Yao Liu, National Taiwan Normal University, Taiwan, liusy@ntnu.edu.tw

S9.14.2 Problem Framing as a Starting Point for Active Participation on the Debate of Environmental Issues

Chuan-Shun Lin, National Kaohsiung Normal University, Taiwan

Shiang-Yao Liu, National Taiwan Normal University, Taiwan

S9.14.3 Promoting Systems Thinking through an Environment Course

Ting-Li Cheng, National Kaohsiung Normal University, Taiwan

Shiang-Yao Liu, National Taiwan Normal University, Taiwan

S9.14.4 The Quality of Students' Argumentation in a Socio-environmental Debate Activity

Uy-Len Lin, National Kaohsiung Normal University, Taiwan

Li-Ting Cheng, National Kaohsiung Normal University, Taiwan

Jeng-Fung Hung, National Kaohsiung Normal University, Taiwan

S9.14.5 An Exploration of Students' Reading Strategies in Texts of Environmental Issues

Sung-Tao Lee, Naval Academy, Taiwan

Tuesday, April 5, 2011

Fu-Pei Hsieh, Kuang-Hua Primary School, Kaohsiung, Taiwan
Yen-Wen Lin, An-Chao Primary School, Kaohsiung, Taiwan

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International Committee Sponsored Session

S10.1 Related Paper Set - Exemplary Research in Science Education from Australia and New Zealand that Fosters Engagement and Understanding

8:30am – 10:00am, Antigua 1

Presider: Sibel Erduran, University of Bristol, United Kingdom

Discussant: Alister Jones, The University of Waikato, New Zealand, ajones@waikato.ac.nz

ABSTRACT: This session is designed to present four research projects taking place in Australia and New Zealand that represents of a range of initiatives in an educational environment where more is expected from teachers of science. The presentations illustrate a range of research approaches as well as cooperation between the school, university sectors and professional groups. Research projects involved primary and secondary teachers and students, practising teachers at the secondary level and initiatives in the first years of university education. The projects explore expanded notions of scientific literacy, possibilities for enhancing the focus on thinking skills within science, approaches that seek to build links with practising scientists, students' families and communities.

S10.1.1 Expert Science Teachers Notions of Scientific Literacy

Deborah J. Corrigan, Monash University, Australia, Debbie.Corrigan@monash.edu

Rebecca Cooper

Stephen Keast

S10.1.2 From Chaos to Small Steps and Manageable Chunks: Supporting Australian Science Teachers Transform their Pedagogy to Teach Thinking Skills

Mary Oliver, University of Western Australia, Australia, mary.oliver@uwa.edu.au

Grady Venville

Philip Adey

S10.1.3 Increasing Teachers' Content Knowledge about the Mining and Mineral Processing Industries by Interacting with Scientists

Dianne Nichols, Education Queensland, Australia, dnich25@eq.edu.au

Dan Churach

Darrell Fisher

S10.1.4 Fostering Parent and Whanau Engagement with Children's Learning: A Strategy to Enhance Children's Science Learning

Bronwen Cowie, The University of Waikato, New Zealand, bcowie@waikato.ac.nz

Kathrin Otrell-Cass

Ted Glynn

Helena Kara

Strand 1: Science Learning, Understanding and Conceptual Change

S10.2 Related Paper Set - Becoming Experts in Science and the Role of Culture and Context

8:30am – 10:00am, Curacao 1

ABSTRACT: The purpose of this paper set is to interrogate notions of what it means to develop expertise in science from critically oriented sociocultural and place-based perspectives, and to offer models and frameworks for describing and explaining the ways in which the complex relationships between science, community/place and self frame science learning. Five papers will be presented. Drawing from related methodologies (longitudinal case study, narrative inquiry and ethnography), each of the manuscripts is grounded in multi-year data of youth who participate in community-oriented formal or informal science programs, and who are from a range of racial, ethnic, and socioeconomic backgrounds and different geographic locations. Findings across papers unpack the importance of cultural practices in

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making scientific knowledge and practice accessible and relevant. Findings also indicate the how scientific expertise is expressed is both place-placed and discourse dependant. Presenters include university researchers, teachers, and youth involved in our research.

S10.2.1 Horizontal and Vertical Learning Dimensions of Urban Youth Investigating Energy Efficiency

Takumi C. Sato, Michigan State University, tsato@msu.edu

Angela M. Calabrese-Barton, Michigan State University

S10.2.2 Vanilla, Strawberries, & School Garden: I Can Show how to Pollinate the Flowers

Nancy Albrecht, University of Minnesota

Bhaskar Upadhyay, University of Minnesota

S10.2.3 Connecting Environmental Issues to Youths' Place-making in Mapping Activities

Giovanna Scalone, University of Washington

Philip Bell, University of Washington

S10.2.4 Saving Energy Means Saving a lot more Moolah!: The role of Economic and Scientific Discourses in Youths' Involvement in the Change a Light, Change Michigan

Shari Rose, Michigan State University

Angela M. Calabrese-Barton, Michigan State University

S10.2.5 Scaffolding Identity and Expertise Development

Shelley Stromholt, University of Washington

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S10.3 Influences on the Biology Classroom

8:30am – 10:00am, Curacao 2

Presider: Allan Feldman, University of South Florida

S10.3.1 Framing Evolution Discussion Intellectually

Kristin L. Cook, Indiana University, kshockey@indiana.edu

Alandeom W. Oliveira, State University of New York

Gayle A. Buck, Indiana University

ABSTRACT: This instrumental case study examines how a secondary science teacher manages the challenge of “framing” evolution discussions intellectually (i.e., orally organizing classroom verbal exchanges about evolution as social events of an intellectual nature). Evolution discussions are viewed as social events that teachers can frame intellectually by focusing on both standard concepts and respect, orienting students toward rigorous expression and criticism of ideas and human agency, downplaying differences in social status, cultivating a moderately humorous mood, and promoting a sense that participation is partially voluntary. The reported findings show that the teacher framed evolution discussions as exchanges mainly about sharing ideas (i.e., personal opinions) and teaching students how to politely communicate evolution. Student participation was framed as moderately playful, partially mandatory, and with a reduced teacher-student social gap. Within this framing, the teacher aligned himself with evolution scientists (whose expertise surpassed his own) and state officials who determined (through state standards) whether evolution discussion should take place, thus positioning himself as a neutral (though biased) facilitator with intermediary expertise and who was legally required (though inclined) to discuss evolution. The main significance of this study is that it provides a robust theoretical framework for analyzing evolution discussion from a social perspective.

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S10.3.2 Factors Potentially Influencing Student Acceptance of Biological Evolution

Jason R. Wiles, Syracuse University & McGill University, jwiles01@syr.edu

ABSTRACT: This investigation explored factors that may influence student acceptance of biological evolution and related concepts, how students perceived these factors to have influenced their levels of acceptance of evolution and changes therein, and what patterns arose among students' articulations of how their levels of acceptance of evolution may have changed. This exploration also measured the extent to which students' levels of acceptance changed following a treatment designed to address factors identified as potentially affecting student acceptance of evolution. Acceptance of evolution was measured using the MATE instrument (Rutledge and Warden, 1999; Rutledge and Sadler, 2007) among participants enrolled in a secondary-level academic program during the summer prior to their final year of high school and as they transitioned to the post-secondary level. Student acceptance of evolution was measured to be significantly higher than pre-treatment levels both immediately following and slightly over one year after treatment. Qualitative data from informal questionnaires, from formal course evaluations, and from semi-structured interviews of students confirmed that the suspected factors were perceived by participants to have influenced their levels of acceptance of evolution. Furthermore, participant reports provided insight regarding the relative effects they perceived these factors to have had on their evolution acceptance levels.

S10.3.3 Pleasing Others and Mastery Goals as Predictors of Biology Students' Individual Science Interest.

Martina Nieswandt, Illinois Institute of Technology, mnieswan@iit.edu

ABSTRACT: This study investigates predictors of grade 12 biology students' (n=27) individual interest. Individual interest is viewed as an emotion and individual physical state and defined as a person's enduring predisposition to attend to and engage in certain activities (e.g., conducting science investigations) or school subjects such as biology. Results of this study indicate that mastery or learning goals, instrumental goals (being future-oriented) and the goal to please others (e.g., the family or the teacher) are predictors of students' individual interest in biology. While these results confirm previous research with respect to the close relationship between mastery goals and students' individual interest, this study's results go beyond previous research. They foremost demonstrate that both instrumental goals and the goal of pleasing others are significantly detrimental to individual interest. This suggests the need to develop a science classroom and instructional context, which reinforces mastery goals while at the same time, downplays the goal of pleasing others and instrumental goals. Such designed learning environments are likely to sustain and deepen students' individual interest in biology.

S10.3.4 Does Whole-Class Talk Influence the Students' Learning in Biology Education?

Julia Rixius, Biology Education, julia.rixius@lrz.uni-muenchen.de

Birgit J. Neuhaus, Biology Education

ABSTRACT: The question how to improve teaching effectiveness in science education – recently raised by international assessment studies like PISA (OECD, 2007) or TIMSS (Baumert et al., 2000) – is important to any educational system that aims to raise the students' learning achievement (Johnson, Kahle & Fargo, 2006). Thus, the presented project explores the relation between academic teacher-student-interaction and the students' achievements in biology classrooms by analyzing a sample of 47 videotaped 9th grade grammar school biology lessons on the topic 'blood and blood circulation'. The different student's and teacher's statements and their scientific accuracy as well as their clarity have been coded with the software 'Videograph'. The students' outcome was raised by a motivation survey, a pre-post-achievement-test, and concept-maps (Jatzwauk et al., 2008; Wadouh et al., 2009). Correlations between the data obtained from the video analysis and the students' outcome were calculated. One important finding is the negative correlation between the amount of teacher's tasks and the acquisition of factual knowledge ($r = -.36$, $p \leq .02$), arguably because the answering time is shortened by a high task-frequency leaving less time to verbalize thoughts. In future, these correlative results can be tested in experimental designs and used for teacher education programs.

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

S10.4 Teachers Learning from Instruction Practice

8:30am – 10:00am, Curacao 4

Presider: Anne L. Kern, University of Idaho

S10.4.1 Effect of Student Learning on Science Teachers' Teaching: The Case of a Form 3 Science Class in Kenya

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

David Anderson, University of British Columbia

ABSTRACT: This paper reports the findings of an investigation into how three Kenyan science teachers' teaching was impacted by their students' learning in a contextualized science curriculum unit that integrated classroom and local Jua Kali experiences. A case study employing narrative methodology revealed three key impacts indicating that the teachers: 1) gained an increased awareness of and understood better their students' science learning abilities that allowed them to take increased responsibility for own learning, 2) developed and accepted new understanding of their teaching roles, and 3) became more critical of how science pedagogy was modeled for them as students and continuing practitioners.

S10.4.2 Factors influencing Secondary Science Teachers' use of Popular Media: The Complexities of Instructional Practice

Michelle L. Klosterman, Wake Forest University, klosteml@wfu.edu

Troy D. Sadler, University of Florida

ABSTRACT: Popular media (e.g., magazines, films, and commercial videogames) are becoming increasingly popular with teachers as viable instructional tools, but there is the potential that without explicit instruction about popular media, inaccurate or incomplete representations of science in media may contribute to students' misunderstandings about science. The goal of this study was to explore secondary science teachers' use of popular media as an instructional tool and focused on the classroom practices of six high school classroom teachers. Data collection consisted of semi-structured interviews and an extended period of classroom observations. In addition of providing a portrait of secondary science teachers' classroom use of popular media, inductive analysis of data revealed that teachers drew upon six distinct knowledge domains when making decisions on how and why to use popular media in the science classroom: a knowledge of context, self, learners, pedagogy, science content, and media. In this paper we describe a model for understanding teacher knowledge and the influence previous experiences have on shaping teachers' instructional decision-making around the use of popular media. Specifically, we highlight the interdependent relationships among teacher knowledge domains and discuss implications for teacher education, science education research, and research in the field of media literacy education.

S10.4.3 A Method to Reconstruct Content and Content Specific Criteria of Video-Documented Science Instruction

Maja Brückmann, University of Kiel, Germany, mbrueckmann@gmail.com

Reinders Duit, IPN Kiel

ABSTRACT: Consistency and coherence of content presented have proven key prerequisites for efficient science instruction. For many years empirical research on instructional quality referred to general quality criteria, for example classroom management whereas subject-specific and content-specific criteria were neglected. To allow the analysis whether the content presented is sound from the science point of view and adequately sequenced a method has been developed to reconstruct the content structure of video-documented science instruction. Logical flow diagrams are used to display the structure of a lesson. They not only allow analyzing the degree of linking but also characterize the various pathways towards the content area teachers follow in their instruction. The logical flow diagrams are developed following a four step procedure. First, a time based coding (10 seconds intervals) based on a system of content categories results in "content scores". Secondly a set of reference content units are coded displaying the sequencing of the content. To analyze the interrelatedness of those content units a manual-based procedure leads to the setting of arrows. On the base of the previous three steps logical flow diagrams are constructed. This method was tested on 37 videotaped physics lessons on the topic "force concept".

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S10.4.4 The Value of Self Study in Learning to Teach New Topics in Chemistry: Case Studies from South Africa

Marissa Rollnick, Wits University, South Africa, marissa.rollnick@wits.ac.za

ABSTRACT: This paper examines three cases of implementation self study practices in STS topics that were being taught for the first time by teachers who expressed a lack of confidence in their knowledge of the underlying subject matter. The self study practices were used as a means of learning to teach the content in a reflective manner that would change teaching approaches. Data across the three cases suggests encouraging improvement in teachers' understanding of the content as well as improved PCK. Teachers also showed more confidence in sharing their work publicly. An unexpected benefit of the study was improved motivation of students who showed increased ability to take responsibility for their learning.

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

S10.5 Learning in Biology, Biotechnology & Nature of Science

8:30am – 10:00am, Curacao 5

S10.5.1 Building the BIKE: Development and testing of the Biotechnology Instrument for Knowledge Elicitation (BIKE)

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

Carina M. Rebello, University of Missouri

Marcelle A. Siegel, University of Missouri

Sharyn K. Freyermuth, University of Missouri

Kemal Izci, University of Missouri

Bruce A. McClure, University of Missouri

ABSTRACT: Identifying students' conceptual scientific understanding is difficult if the appropriate tools are not available for educators. Concept inventories have become a popular format to assess student understanding, however traditionally they are multiple-choice tests. The U.S. National Science Education Standards advocates that assessments should be reform-based, contain diverse sampling methods, and should align with instructional approaches. To date, no instrument of this type targeting student conceptions in biotechnology has been developed. We report here the development, testing and validation of a 35-item Biotechnology Instrument for Knowledge Elicitation (BIKE) that includes a mix of question types. The design phase contained 9 steps including a literature search for content, student-interviews, a pilot test as well as expert review. Cronbach's alpha on the pre/post test was 0.664 and 0.668 respectively, indicating the BIKE has internal consistency. Cohen's kappa for inter-rater reliability among the 6525 total items was 0.684 indicating substantial agreement among scorers. Item analysis demonstrated that the items were challenging, there was discrimination among the individual items, and there was alignment with research-based design principles for construct validity. This study fills a gap in the literature by providing a reliable and valid conceptual understanding instrument in the understudied area of biotechnology. v

S10.5.2 Differential Understandings of Nature of Science Among Undergraduate Biology Students

Elisabeth E. Schussler, University of Tennessee - Knoxville, eschussl@utk.edu

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ABSTRACT: The development of nature of science (NOS) understanding in college students, particularly science majors, is not well understood. Undergraduate students taking biology classes at a large southern university completed 11 items on the VOSTS instrument and their overall scores were analyzed by several demographic categories. There were 265 students who completed the survey, the majority of whom were female (N=167), freshman (N=110), biology majors (N=111), had completed one biology course (N=172), and were seeking to enter a medical profession (N=85). Analyses indicated that VOSTS scores were not significantly different based on gender, year in school, or career path. There were significant differences, however, among majors and based on the number of core biology courses students had completed. Certain biology majors and students who had completed more biology courses selected more appropriate answers on the same two VOSTS questions dealing with supernatural influence on science and theories being invented. The results suggest that some NOS aspects are being learned implicitly by biology majors, and that different groups of students – even among the discipline of biology – have different understandings of NOS.

S10.5.3 Benefits Observed in the Research Laboratory Setting Don't Always Generalize to the Classroom Setting

Cheryl C. Berg, Arizona State University, cheryl.berg@asu.edu

Dale R. Baker, Arizona State University

ABSTRACT: Emergent processes are distinguished from non-emergent processes on the basis of the qualitative relationships among the agents' interactions and the causal relationships between the agents' interactions and the pattern. Research suggests students often have robust misconceptions about emergent processes (such as diffusion) because they do not have the mental model to interpret these processes. This study investigates the extent to which a domain-general understanding of emergent processes can help provide students with an enhanced understanding of diffusion and osmosis. Sixty-six community college students enrolled in an introductory biology course comprised the participants. Students' prior knowledge about emergent processes, diffusion, and osmosis were assessed by pre-tests. The treatment group received the intervention, an instructional module about the differences between emergent and non-emergent processes. Both treatment and control groups received the same instruction about diffusion and osmosis, and were given post-tests to assess whether they learned the concepts, and whether they were able to achieve a deep understanding that resulted in a comprehension of the transport of substances across cell membranes. No statistically significant differences were found between the two groups based on the learning measures. Discussion includes the challenges of generalizing to the classroom observations made in laboratory research settings.

S10.5.4 What's in a Word: Student Conceptions of and Learning About 'Allele'

Jennifer L. Momsen, North Dakota State University, jennifer.momsen@ndsu.edu

Sara A. Wyse, Bethel University

Tammy M. Long, Michigan State University

Speth Elena Bray, St. Louis University

ABSTRACT: Genetics-related headlines are on increasing, with stories ranging from personalized medicine to homeland security. The difficulty of teaching and learning genetics, however, remains constant. The concept of allele, for example, while superficially simple, represents complex connections across scales of genetics. This study seeks to (1) identify students' prior conceptions of allele and (2) determine whether an iterative, model-based pedagogy helps students understand and integrate allele into the broader hierarchy of genetics. In a pilot study of 312 introductory biology course students, we found only 3% could correctly define allele at the start of the semester and even fewer were able to correctly integrate allele into a conceptual model of genetics. Following iterative, model-based instruction, students were able to construct models on the final in exam in which 70% correctly connected 'allele' to 'gene' and 33% to 'nucleotide' or to 'protein', albeit with varying levels of correctness. Approximately 27% of students connected allele to phenotype, but few of these connections were completely accurate. These results demonstrate the difficulty in understanding the concept of 'allele', a common core concept in genetics instruction, and underscore a need for explicit instruction that fully integrates 'allele' into the broader genetics curriculum.

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Strand 6: Science Learning in Informal Contexts

S10.6 Symposium - Science Cafés: Lessons Learned and New Directions for Research

8:30am – 10:00am, Curacao 6

Presider: Susan Foutz, Institute for Learning Innovation

Discussant: Martin Storksdieck, The National Academies, Board on Science Education

Presenters:

Katey Ahmann, North Carolina Museum of Natural Sciences

Michelle Hall, Science Education Solutions, Inc

Wendy Hansen, Pacific Science Center

Julie Mcnalley, Pacific Science Center

Christine Reich, Museum of Science, Boston

Menna Selvakumar, Pacific Science Center

ABSTRACT: Science cafés have become a popular way to engage informal audiences in discussion of current science and issues at the nexus of science and society. But what have we learned so far about organizing and evaluating these programs? What's next in researching these dialogue-based events? In this interactive session, practitioners who have organized science cafés and evaluators of cafés will engage the audience in a dialogue on the café format and the possibilities for research. The panelists represent café programs organized by museums, programs hosted in pubs and restaurants, programs aimed at an adult audience, as well as café programs specifically designed to attract teens. This wide range of panelist experience supports the session format: after learning about each program represented, session attendees will be invited to move to one of three tables with panelists to discuss: 1) lessons learned from hosting cafés and how evaluation results were used to inform the café programs, 2) methodologies for studying science cafés and other dialogue-based events, and 3) new directions for researching science cafés. At the end of the discussion period, attendees and panelists will reconvene to share their conversations and hear from an expert discussant.

Strand 7: Pre-service Science Teacher Education

S10.7 Pedagogical Content Knowledge of Preservice Teachers

8:30am – 10:00am, Curacao 7

Presider: Frederick Freking, USC Rossier School of Education

S10.7.1 The Connection between Content Knowledge and Pedagogical Content Knowledge in Groups of Pre-service and In-service Physics Teachers

Andreas Borowski, University Duisburg-Essen, andreas.borowski@uni-due.de

Sophie Kirschner, University Duisburg-Essen

Hans E. Fischer, University Duisburg-Essen

ABSTRACT: According to Shulman, teachers' pedagogical content knowledge is a special amalgam of content knowledge and pedagogical knowledge. Content knowledge and pedagogical knowledge are correlated substantially with pedagogical content knowledge, but they are two separate knowledge categories. In this study, the content knowledge and pedagogical content knowledge of a group of 84 in-service and pre-service physics teachers were investigated. Two previously developed and evaluated model-based paper-and-pencil-tests were used. First, content knowledge and pedagogical content knowledge were compared based on education level. Second, the connection between both education level-based knowledge categories was analyzed. Analysis of the data shows a significant increase in content knowledge over the phases of teacher education. Pedagogical content knowledge increases significantly only at the beginning of education, but then plateaus later on. The connection between both knowledge categories has a different correlation, also depending on education level. Remarkably, a part of the results indicate that teachers do not necessarily need content knowledge to have a certain amount of pedagogical content knowledge. This has lead to the question: How much content knowledge does a teacher need, and which content knowledge must a student learn during teacher education?

S10.7.2 Examining Pre-service Non-Experienced Secondary Science Teachers' Pedagogical Content Knowledge

Nadya Rizk, American University of Beirut, ngr03@aub.edu.lb

Saouma B. Boujaoude, American University of Beirut

ABSTRACT: This study examined the PCK of four pre-service non-experienced secondary science teachers who were finishing their preparation program. A qualitative approach was used that generated rich descriptions of teachers' PCK. Three instruments were used for data collection: (1) unit plan followed by a semi-structured interview, (2) peer teaching lesson followed by a guided case analysis, and (3) a CoRe matrix followed by a semi-structured interview. An analysis framework for defining PCK consisting of six dimensions was utilized to derive a coding scheme that contained descriptors for each dimension. Data were coded and profiles containing descriptors of teachers' PCK in planning, action and reflection were generated. Then, data bits, each consisting of three parts - main idea, how it was applied and how it was reflected upon - were used to generate teachers' profiles. Findings revealed that teachers' PCK profiles ranged from poor to proficient. Also, teachers had moderate knowledge of students and demonstrated consistently the same level of proficiency across the dimensions 'knowledge of instructional strategies', 'orientations to teach science' and 'knowledge of assessment'. Findings were interpreted by appealing to theories of learning and transfer. Implications for research, teachers education programs and teacher educators were discussed.

S10.7.3 Use of a Venn Diagram to Introduce Pedagogical Content Knowledge to Pre-Service Elementary Teachers

Susan A. Everett, University of Michigan-Dearborn, everetts@umd.umich.edu

Charlotte A. Otto, University of Michigan-Dearborn

ABSTRACT: In a science course taken prior to student teaching, we incorporated elements of pedagogical content knowledge (PCK) into assignments related to action research projects conducted by pre-service elementary teachers. We also introduced these future teachers to a three-circle Venn diagram as a graphic method of keeping track of each primary component of PCK and the interactions among them. Each circle of the diagram represented content, context and pedagogy respectively. We concluded that three-circle Venn diagram is an easily understood, graphic method of illustrating the interplay between the three main components of PCK.

Strand 7: Pre-service Science Teacher Education**S10.8 Raising Performance Expectations for Novice Teachers: The Promise of Pedagogical Tools and Core Practices**

8:30am – 10:00am, Bonaire 7

Discussant: Sherry A. Southerland, Florida State University

Presenters:

Mark Windschitl, University of Washington, mwind@uw.edu

Jessica Thompson, University of Washington

Melissa Braaten, University of Washington

David Stroupe, University of Washington

Elizabeth Wright, University of Washington

ABSTRACT: We report on research studies of tools designed to support expert-like teaching by early career educators. These products, ranging from discourse tools to a teacher performance progression for enacting Model-based Inquiry, were developed using data from a four-year investigation of how novice science teachers learn to take up ambitious forms of practice in the classroom over time. Based on this longitudinal work we offer a comprehensive explanatory framework, describing how and why novices appropriate, transform, or reject reform-based teaching practices. We then present a system of pedagogical tools, tailored to the needs of beginners, and the results of testing these tools in various settings, including pre-service preparation, student teaching, and first year of professional work. In conclusion, we propose a set of tool-supported core instructional practices for pre-service and early career teachers.

Strand 8: In-service Science Teacher Education**S10.9 Online Learning**

8:30am – 10:00am, Curacao 8

Presenter: Lisa A. Brooks, The University of Toledo

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S10.9.1 Teachers' Professional Development via Distance Learning - Literature Review and Steps towards Implementation

Orit Herscovitz, Technion - Israel Institute of Technology Ort Braude College, orither@technion.ac.il

Zvia Kaberman, Technion - Israel Institute of Technology

Yehudit Judy Dori, Technion - Israel Institute of Technology

ABSTRACT: Distance learning (DL) enables the learner to be flexible with respect to time and distance and provides for individual adaptation of interest, pace, and academic level. Teaching online is different from teaching face-to-face and needs its own set of pedagogies. The literature review indicates that factors examined in DL studies refer to learner characteristics, such as extent of the learner's participation in the learning process, views and attitudes towards DL, academic achievements, and the effectiveness of technology usage. Characteristics and findings of various studies as well as teachers' role and professional development in an era of virtual classrooms are reviewed and analyzed. We are currently taking the first steps in developing a DL program aimed at granting Assessment Certificate. The program is designed to prepare graduates in science or engineering education to carry out assessment of projects in a variety of domains. The attendees will be trained as external or internal agents in conducting ongoing and final evaluation of large-scale educational projects. Teachers in this program will gain experience in learning as students and teaching as teachers via DL and will have the opportunity to create a community of teachers who are expert in assessment, sharing ideas and assessment instruments.

S10.9.2 Examining the Student Impact Following an Online Professional Development Course for High School Biology Teachers

Scott Strother, Education Development Center, sstrother@edc.org

Lauren B. Goldenberg, Education Development Center

ABSTRACT: Teacher professional development is usually designed with the ultimate goal of improving student learning through improvements in teacher knowledge and practices, yet relatively few studies have examined the direct relationship between teacher professional development and student knowledge. In the current study, we aim to understand the relationship between a high-quality, online professional development program for high school biology teachers and students' biology content knowledge. The professional development program aims to enhance high school biology teachers' content knowledge, pedagogical content knowledge, and use of digital resources. In addition, we explore the moderating influence of program duration on student impact. The study included 632 students of 32 teachers who completed the professional development course in the summer, and 1,409 students of 55 teachers in a control group. We found that students in the treatment condition had a stronger rate of growth across the year in biology content knowledge compared to the control group. We also discovered that stronger impact occurred with the slightly shorter, more focused version of the course. With this paper, we hope to contribute to the understanding of important predictors of students' biology achievement, as well as to highlight the importance of professional support for high school biology teachers.

S10.9.3 Classroom Implementation and Student Engagement in an Online Inquiry Involving Scientists as Mentors

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

Laura Ruebush, Texas A&M University at College Station

Cheryl Ann Peterson, Texas A&M University at College Station

Julia Johnston, Texas A&M University at College Station

Tori Hollas, Texas A&M University at College Station

ABSTRACT: Pre- and post-test assessments of science teachers' content knowledge resulting from professional development (PD) workshops tell only a small part of the full story about the outcomes associated with high-quality PD. Often lost are data regarding the impact of PD on teachers' beliefs, attitudes, and practice in the classroom and on their students' science learning. Four teachers volunteered for classroom observations and follow-up interviews after being involved in PD associated with learning to provide open-ended inquiry experiences and use of an innovative online learning environment that included practicing plant biologists as mentors during their students' classroom inquiries. Case studies of four secondary school classrooms describe teachers' school-year implementations and students'

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performance after a ten-day summer workshop providing teachers with open-ended inquiry experiences and training in the use of the online mentoring platform. Theories of Albert Bandura guided the design of research questions focused on understanding the interactions between and among teachers' beliefs, attitudes, and practice, the classroom learning environment, teacher's classroom implementations and students' use of the online inquiry environment.

Strand 8: In-service Science Teacher Education

S10.10 Related Paper Set - Teacher Entrepreneurial Leadership for Transforming Science Teaching and Learning

8:30am – 10:00am, Bonaire 8

ABSTRACT: There have been increasingly urgent and well justified calls for transforming precollege education for the purpose of maintaining the United States competitiveness and leadership in science, technology, engineering, and mathematics (STEM). Central to such a transformation, we believe, is a new generation of entrepreneurial STEM teacher leaders empowered with the mindset and skills to envision, enact, and realize innovations aimed at improving science learning for all students. In this related paper set, an interdisciplinary research team shares multi-threaded conceptual and empirical studies aimed at building theory for informing systemic, long-term professional growth programs and partnerships aimed at developing entrepreneurial K-12 science teacher leaders through translating, transforming, synthesizing, and testing elements from scholarship around business and social entrepreneurs, and entrepreneurship in higher education. This work is undertaken in the context of a large-scale project funded by the National Science Foundation and aimed at integrating entrepreneurship into modalities for the development of science teacher leaders in the context of K-12 schooling.

S10.10.1 [MSP]: The Partnership's Conceptual Framework and Approach

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

Anita Martin, University of Illinois at Urbana-Champaign

Ryan Summers

S10.10.2 From Procedural Change to Substantive Innovation: Science Teachers and the Entrepreneurial Mindset

Jeanne Koehler, University of Illinois at Urbana-Champaign

Liora Bresler, University of Illinois at Urbana-Champaign

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

S10.10.3 Learning, Leadership, and Innovation in Science Teaching as Manifested in Teachers' Social Networks

Wei Gao, University of Illinois at Urbana-Champaign

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

Caroline Haythornthwaite, University of British Columbia

S10.10.4 A Framework for Catalyzing Innovation for Student, Class, and School Impact as Manifested by the Actions of Entrepreneurial Teacher Leaders

Raymond Price, University of Illinois at Urbana-Champaign

Janet Gaffney, University of Illinois at Urbana-Champaign

Strand 10: Curriculum, Evaluation, and Assessment

S10.11 Science, Language, and Literacy

8:30am – 10:00am, Bonaire 1

Presider: Gavin W. Fulmer, National Science Foundation

S10.11.1 Student Learning Gains: Results from a PD Program which Incorporated Language Development Strategies in Science

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Lauren M. Shea, University of California, Irvine, LShea@uci.edu

Therese B. Shanahan, University of California, Irvine

ABSTRACT: Most of the approximately 1.6 million English learners (ELs) in K-12 education in California are taught by mainstream teachers in English-Only classrooms. English learners are faced with the dual challenge of acquiring English while learning academic content through the medium of the new language, and therefore need specific accommodations to achieve in both English and the content areas. Unfortunately, the majority of teachers who are responsible for the academic success of EL students do not have the breadth of pedagogical preparedness to ensure student achievement. Using hierarchical linear modeling, this paper explores the effects on student outcomes in language arts and math from one professional development program which trained teachers how to incorporate language development skills into science content lessons.

S10.11.2 Lexical Ambiguity in Evolutionary Discourse: Implications for Teaching, Learning, and Assessment

Meghan A. Rector, The Ohio State University, rector.43@osu.edu

Ross H. Nehm, The Ohio State University

Minsu Ha, The Ohio State University

ABSTRACT: Much of the language that is used to talk about evolution is inherently ambiguous; many terms have different meanings depending on the context in which they are used (e.g., 'adapt,' 'fit,' 'need,' etc.). Our study examines the intended meaning of such "multivalent" evolutionary language as expressed by a large sample (n = 504) of undergraduate biology students. Specifically, we examined three different classes of multivalent evolutionary terms: (1) terms that have ambiguous meaning in evolutionary discourse but have unambiguous meaning in everyday discourse (e.g., pressure); (2) terms that have unambiguous scientific meaning and unambiguous everyday meaning (e.g., select, adapt); and (3) terms that have no apparent scientific meaning but clear everyday meaning (e.g., need, must). Using an automated, computerized assessment cascade system, we examined the frequency with which biology majors (1) used multivalent terms, and (2) defined and explained the meaning of such terms. We found that approximately 24% of undergraduate biology students spontaneously used multivalent terms in their evolutionary explanations. The majority of explanations using multivalent terms employed faulty evolutionary reasoning, apparently as a consequence of the conflation of everyday language and scientific language. We discuss the implications of these findings for biology teaching, learning, and assessment.

S10.11.3 Development and Validation of Instrument to Measure Scientific Literacy for the 21st Century

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

Sung-Won Kim, Ewha Womans University

Hyunju Lee, Ewha Womans University

Kongju Mun, Ewha Womans University

Sung-Youn Choi, Ewha Womans University

Joseph S. Krajcik, University of Michigan

Namsoo Shin, University of Michigan

ABSTRACT: In order to meet the demands of the 21st century global society, it is necessary to rethink current notion of scientific literacy and to propose an expanded vision of scientific literacy which includes more global perspectives and competencies. We, in this paper, propose a new framework for scientific literacy for the 21st century, which consisted of 5 dimensions, and discuss the development of the Science Literacy Questionnaire (SLQ) for accessing these dimensions. The SLQ consists of 20 multiple choice items for content knowledge, and 48 Likert-scale items for non-content areas (i.e. habits of mind, the affective realm, science as a human endeavor, and metacognition). In order to validate the items of SLQ, we administered the survey to 3202 Korean students in the secondary level and conducted various statistical analyses including exploratory and confirmatory factor analysis. An exploratory factor analysis (N=1607) identified eight factors and a confirmatory factor analysis (N=1595) provided model fit indexes that supported that the model was a good fit for the data. We conclude by presenting the SLQ results of Korean students and group comparisons by gender and grade level.

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S10.11.4 Assessing Scientific Literacy: Content Knowledge, Skills, and Contextualization

Cathy L. Farrar, University of Missouri-St. Louis, farrarc@atgmail.com

Jennifer M. Hope, University of Missouri-St. Louis

ABSTRACT: This paper describes the development and analysis of a composite scientific literacy assessment. Using an apprenticeship model, a set of standards was developed with input from science journalists, science educators, and science education researchers. The standards focus on five aspects (context, credible sources, finding information, factual accuracy, and relevance). The assessment utilizes science media articles, images, and graphs to address these standards. The data for this study is part of a larger project aimed at improving student scientific literacy through the incorporation of science journalism practices in high school classrooms.

Strand 11: Cultural, Social, and Gender Issues

S10.12 Students and Science: Issues of Cultural Capital

8:30am – 10:00am, Bonaire 2

Presenter: Barbara A. Burke, Cal Poly Pomona University

S10.12.1 Shelter Design: Problem Solving Lesson Using a Culturally Relevant STEM Topic

Younkyeong Nam, University of Minnesota, younkyeong@gmail.com

Mi Sun Park, University of Minnesota

Young Rae Kim

Gillian H. Roehrig, University of Minnesota

Tamara Moore, University of Minnesota

ABSTRACT: This study presents an out-of-school problem solving module we designed for American Indian students, using a culturally relevant STEM topic, Shelter design for severe weather conditions. We implemented the lesson at an American Indian reservation during a summer program and collect student data through pre-post STEM content knowledge tests, drawings and explanations about shelter models in the students' group worksheet, classroom observations. We used interpretive and inductive approach to analyze data. This study shows that our problem solving module using culturally relevant STEM topic helps the American Indian students to solve a complex, real-world problem and to improve their content knowledge by offering unique experience of exploring each condition that they need to consider to solve the problem. This study also shows that how the students' prior experience and cultural knowledge affect their problem solving processes. This study has implications for further research on designing problem solving lessons using culturally relevant STEM topics for the students who are from historically marginalized populations.

S10.12.2 Urban Fifth Graders Connecting Geoscience to their Spaces and Places

Katie L. Brkich, University of Florida, ecobeagl@yahoo.com

ABSTRACT: This paper reports on a portion of a qualitative research study that used constructivist grounded theory and the framework of place-based education to investigate how urban fifth graders describe, identify, and make connections between formal/school earth science concepts and their own everyday lives. Results show numerous disconnects and misconceptions between Earth Science as taught in class and Earth Science as urban elementary students found it in their environments outside of school. Five urban fifth grade participants were observed during their earth science unit and interviewed three times over the course of the unit. Data collected involved individual interviews supported by auto-driven photo elicitation and student-created maps. Data analysis occurred concurrently with data collection and yielded results and implications for a number of areas including urban science education and earth science education.

S10.12.3 What Inuit Students Have to Say about Science Teaching and Learning

Brian E. Lewthwaite, University of Manitoba, Lewthwaite@xtra.co.nz

Barbara Mcmillan, University of Manitoba

Rebecca Hainnu, Qikiqtani School Operations

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ABSTRACT: In this study, we have investigated, through interviews, conversations, questionnaires, and observations, perceptions of learning success of northern Qikiqtani (Baffin Island) of Nunavut Inuit middle years (grades 5+8) students and the classroom pedagogy influencing their success, in particular their learning in science. Most of the processes identified as contributors to successful learning were culturally located. Students also placed importance on teachers who cared not only for them as people, but also for their performance as learners. Based upon students' information, we have presented a profile of the characteristics of effective teachers in Inuit schools to promote learning within a positive environment.

S10.12.4 Silencio en Ciencia: A Longitudinal Case Study of Julio's Silencing in School Science

Jean Rockford, The University of North Carolina at, j_rockfo@uncg.edu

Heidi B. Carlone, The University of North Carolina at Greensboro

ABSTRACT: This longitudinal ethnographic case study of a Latino student's school science experiences from 4th to 6th grades, presents Julio, an excellent Latino science student, thwarted into a position of silence in science over 3 school years. Our study comprised 8-40 hours/year of videotaped classroom observations, yearly student and teacher open-ended interviews, surveys, and classroom artifacts. We found that it was the incorporation of his specific Latino sociocultural values and repertoires of practice into school science which enabled Julio to initially excel and identify with science, and not just reform-based inquiry classroom practices alone. The subsequent lack of informed sociocultural incorporation led to Julio's silencing in school science. This study makes a case for the necessity of amplifying the voices of Latinos and honoring their specific sociocultural values within science education to achieve equity in science. Utilizing a Latino critical race theory (LatCrit) lens, this study aims to amplify Julio's voice to uncover what exists for Latinos currently, where we should go in effective science education that amplifies Latino voices, and what could be if we were to inform ourselves as science education researchers to the rich sociocultural fabric of Latinos.

Strand 12: Educational Technology

S10.13 Symposium - Video Analysis to Support Teacher Learning: Approaches, Impact, Challenges, and Gaps

8:30am – 10:00am, Bonaire 3

Presider: Kathleen Roth, BSCS, kroth@bscs.org

Discussant: Robert Hollon, University of Wisconsin, Eau Claire

Presenters:

Karen B. Givvin, University of California, Los Angeles (UCLA)

Carla Zembal-Saul, Pennsylvania State University

Maulucci Maria S. Rivera, Barnard College

ABSTRACT: While videos of science teaching are frequently used in preservice teacher education and inservice professional development programs, they are less often used programmatically as tools to support teacher learning from analysis of practice. In addition, there is limited research studying the impact of video analysis on science teacher learning and development. In this session, researchers report on studies investigating the impact of video analysis on preservice and inservice science teacher learning and development. Each researcher will use a video example to help describe the role that video analysis plays in the program. In addition, researchers will share findings about the impact of the video analysis work on teacher learning and/or practice. Finally, each researcher will identify (a) two challenges of developing and conducting video-focused teacher learning programs and research studies, and (b) one-two gaps in our research in this area. Attendees will receive a handout with the list of challenges and research gaps identified by the presenters. This list will be used to start a discussion involving all attendees and presenters. A Discussant/Moderator will facilitate this discussion about the opportunities, challenges, and research gaps in this line of work.

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Strand 13: History, Philosophy, and Sociology of Science

S10.14 Nature of Science and Science Teachers

8:30am – 10:00am, Bonaire 4

Presider: Lisa Martin-Hansen, Georgia State University

S10.14.1 Developing Inservice Teachers' Views of NOS and Inquiry: Immersion in Authentic and Relevant Paleontological Research

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

Daniel K. Capps, Cornell University

Maya Patel, Cornell University

Robert Ross, Paleontological Research Institution in Ithaca, New York

ABSTRACT: This paper reports on the second year of a two-year project designed to influence teachers' views of nature of science (NOS) and inquiry using an authentic research setting. The project also used innovative curricular materials centered in inquiry, NOS, and evolutionary concepts. The theoretical framework involved the constructs of situated cognition and social constructivism. We used a mixed methods approach and multiple data sources, (videotaped fieldwork, teacher presentations, written reflections, and interviews). We built on findings from our previous research, investigating the impact of geological fieldwork related to an authentic paleontological study on views of NOS and inquiry of 18- 5th-9th-grade teachers. In the first year teachers focused on the examination of real fossils in the field and relevant content in biological evolution, geology, inquiry, and nature of science. The current study pushed these same teachers to formulate their own scientific questions and hypotheses. They engaged in hypothesis testing, data analysis and developing explanations, all hallmarks of science. These experiences, combined with reflection, appeared to enhance teachers' views of NOS and inquiry. The authenticity and relevancy of the fossil investigation contributed to teachers' developing understandings of many of the tenets of NOS and inquiry.

S10.14.2 Understanding Pre-Service Teachers' Frameworks for Perceiving the Risks of New Technologies

Grant E. Gardner, East Carolina University, gardnerg@ecu.edu

M. Gail Jones, North Carolina State University

Sarah W. Robert, North Carolina State University

ABSTRACT: Rapid growth in technological research and development (such as bio- and nano-technologies) places a unique burden on science educators to: a) prepare future scientists and engineers, and b) prepare scientifically literate citizens. Accelerated development within these fields often means that much of the science content driving these technologies will remain unknown to the majority of students, citizens, and science educators. However, research shows that lack of content knowledge does not necessarily preclude individuals developing stable and polarizing attitudes and perceptions. This study focuses on the perceptions of risks of new technology as a prominent factor in attitude formation. Participants were 66 pre-service math and science educators. Data was collected through surveys and semi-structured interviews. Results show that participants construct a similar perceptual framework for nano- and bio-technologies despite variability in content knowledge. This implies that helping pre-service students develop mature attitudes that will motivate them to access needed information and make decisions about these "new" technologies might be a more manageable pedagogical goal than attempting to deliver copious amount of content (that could become quickly outdated).

S10.14.3 Developing Prospective Teachers' Ideas about Scientific Models in a Science Content Course

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

Brandy Skjold, Western Michigan University

ABSTRACT: The purpose of this paper is to describe the instruction and effectiveness of an undergraduate biology course on prospective elementary and middle school teachers' conceptions of scientific models. The course utilizes multiple representations of biological phenomena to teach about cells, DNA, and molecular processes while drawing explicit attention to the development and use of scientific models. The research questions are (1) What are prospective teachers' conceptions of scientific models before and after a biology course that utilizes multiple models and explicit

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instruction about models and modeling? (2) What examples do prospective teachers use to support their ideas about models? Results indicate most participants initially considered models simply as representations of objects to be visualized. Other initial conceptions included the idea that a model is the process scientists use when they do an experiment, and a chart scientists use to record their findings. By the end of the course, more participants recognized models as representations of scientists' ideas and the role models have in demonstrating and explaining processes in science. Yet, despite the instructional attention, few came to recognize the role of models in making and testing predictions. Implications of the findings are discussed.

S10.14.4 Experienced Science Teachers' NOS Teaching Practices and Associated Factors Accounting for Those Practices

Benjamin C. Herman, University of South Florida, bcherman@usf.edu

Michael P. Clough, Iowa State University

Joanne K. Olson, Iowa State University

ABSTRACT: Despite the consensus present in science education literature on why and how the nature of science (NOS) should be taught, teachers still fail to effectively implement the NOS in their classrooms. This qualitative study investigated the NOS teaching practices of thirteen experienced science teachers, and factors affecting these practices. All teachers studied were former students from the same NOS focused secondary science teacher education program at a large Midwestern university in the United States. Analysis of the thirteen participants' teaching practices revealed four were high implementers, five were medium implementers, and four were low implementers of the NOS. Factors associated with participants' NOS teaching practices included their: general reform-based teaching practices; perceived utility value for NOS teaching; self reflection abilities; considerations of how people learn; understanding of NOS pedagogy; participation in support networks with others from their preservice program; personal responsibility to implement the NOS; and ability to cope with teaching constraints. This session will describe in detail these teachers' NOS implementation practices and factors associated with these practices. Furthermore, because these factors appear to be interconnected, a model was developed and will be presented that illustrates possible relationships between them and their influence on NOS instruction.

Strand 14: Environmental Education

S10.15 Symposium - Place-based Education in the Urban Environmental Context: What Have We Learned as Science Educator and Scientists about Engaging Urban Students in Environmental Studies?

8:30am – 10:00am, Bonaire 5

Presider: Jennifer D. Adams, Brooklyn College-CUNY

Presenters:

Rebecca Boger, Brooklyn College-CUNY

Kimberly Handle, Brooklyn College-CUNY

Kendall Eskine, The Graduate Center-CUNY

Jesse John, Brooklyn College-CUNY

Adam Johnson, The Graduate Center-CUNY

Michael Magee, The Graduate Center-CUNY

Sheila Nightingale, The Graduate Center-CUNY

Reena Rahi, The Graduate Center--CUNY

Amy Ferguson, Brooklyn Academy of Science and the Environment and The Graduate Center--CUNY

ABSTRACT: Much of the literature about urban science teaching and learning point to schools lacking in science resources, underprepared teachers and decreased student motivation (e.g. Coble, Smith, and Berry, 2009). However, situating science teaching and learning in an urban environmental context offers the potential of a diverse array of science learning experiences that are content-rich, motivating to urban students and of local relevance to the lives of students, teachers and community-based stakeholders. Recognizing this potential, an urban-based public university in partnership with local public schools and community-based partners developed an NSF-funded project. The goal of this symposium to discuss how urban science teaching and learning could be enhanced with an environmental place-based

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education approach. Participants will discuss their relevant research and experiences with the project to demonstrate how different stakeholders—graduate fellows, teachers, urban high schools students and university faculty—experience the place-based focus of the project and major lessons learned from this approach to urban science teaching and learning.

International Committee Sponsored Session

S11.1 Symposium - NARST's LSEP and SAARMSTE's 2010 Research School

10:15am – 11:45am, Antigua 1

Presiders:

Bill Kyle, University of Missouri-St.Louis, USA

Sibel Erduran, University of Bristol, United Kingdom

Presenters:

Marissa Rollnick, Witwatersrand University, South Africa

Mariana G. Hewson, Synthesis Consulting in Healthcare and Education

Julie A. Luft, Arizona State University, USA

Eduardo F. Mortimer, Universidade Federal de Minas Gerais, Brazil

Audrey Msimanga, Witwatersrand University, South Africa

Simasiku Siseho, University of the Western Cape, South Africa

Washington Dudu, Witwatersrand University, South Africa

Linda Keen-Rocha, Witwatersrand University, South Africa

ABSTRACT: In March 2010, NARST's International Committee approved an application to the Linking Science Educators Program (LSEP) from the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE). The LSEP grant supported the travel costs of two NARST Resource Persons, Julie Luft and Eduardo Mortimer, to attend the 2010 SAARMSTE Research School, held in South Africa, June 7–11, 2010. The proposed session for the 2011 NARST Annual Meeting will provide a description of the 2010 Research School and the role played by the two NARST Resource Partners, an analysis of different forms of feedback provided by participants during the school, reflection by school facilitators, including Resource Partners, about their experience, and reflections by a few participants on the role played by their experience at the school in furthering their research.

Strand 1: Science Learning, Understanding and Conceptual Change

S11.2 Related Paper Set - Implications of Research on K-12 Student and Teacher, and Undergraduate Apprenticeships for Science Teaching and Learning

10:15am – 11:45am, Curacao 1

Presider: Troy D. Sadler, University of Florida

ABSTRACT: The purpose of this Related Paper Set is to report on recent research on research apprenticeships. The five papers in this set look at three levels of participants in two types of settings. The levels are K-12 students (elementary, middle school, and high school), undergraduates, and practicing K-12 teachers. The settings are summer programs in which the participants are immersed in science research, and elementary and middle school classrooms. The research questions that guide the studies focus on what participants learn in the research apprenticeships and how the characteristics of the settings affect what is learned. By presenting the papers as a set, we provide the opportunity for the comparison and contrast across levels and settings to gain a better understanding of how people learn to do science, and to consider how what we might learn from such research can inform the teaching of science for deeper understanding in school settings. The findings from this paper set can also be used to improve research apprenticeship experiences so that teachers are better equipped to help their students learn how science is done. In addition, the findings can be used to improve the research apprenticeships for students at all levels.

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S11.2.1 WYDIWYL: What do High School Students Really Learn through Research Apprenticeships?

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

Troy D. Sadler, University of Florida

S11.2.2 Take 10 Teachers, Add 2 Scientists, Stir in the National Reform Goals, and Let Marinate for 6 Weeks

Margaret R. Blanchard, North Carolina State University

Victor D. Sampson, Florida State University

S11.2.3 Authentic to Whom? A comparison of two different models for Research Experiences for Teachers

Barry Golden, Florida State University

Sherry A. Southerland, Florida State University

S11.2.4 Student Learning in a Research Experience for Undergraduates Program

Allan Feldman, University of South Florida

Dilek Ozalp, University of South Florida

Sarah Johnstone, University of South Florida

S11.2.5 What Happens when you Engage Teachers and Children in Authentic Paleontological Work?

Barbara A. Crawford, Cornell University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S11.3 Students' Attitudes

10:15am – 11:45am, Curacao 2

Presenter: Lawrence Flick, Oregon State University

S11.3.1 Conceptual and Methodological Issues in the Measurement of Attitudes Towards Science

Michael R. Kotowski, University of Tennessee, Knoxville, mkotowsk@utk.edu

Mehmet Aydeniz, University of Tennessee, Knoxville

ABSTRACT:

S11.3.2 Adolescents' Declining Motivation to Learn Science: Inevitable or not?

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

Dana Vedder-Weiss, Weizmann Institute of Science

ABSTRACT: This study argues for the need to clarify the attitude construct in science education. After positing a conceptual definition for attitudes derived from the social psychology and persuasion literatures, this study makes a demarcation between science attitudes and attitudes towards science. Based in this conceptual clarity, the study offers a constructive critique of five commonly used measures of attitudes in science education and offers a theoretically grounded alternative. Data gathered to test the alternative measure's validity and reliability was in the main consistent with strong validity and reliability claims for the new measure. Implications for science education are discussed.

S11.3.3 Teaching and Learning Physics: The Impact of Classroom Management on Student Achievements

Katharina Fricke, University of Duisburg-Essen (Germany), katharina.fricke@uni-due.de

Hans E. Fischer, University of Duisburg-Essen (Germany)

ABSTRACT: A loss of students' motivation, interest and performance in science learning after having changed from elementary to secondary school is a domain specific issue almost all over the world. Regarding Germany, large scale assessments show that outcomes of German students' science learning decrease significantly when they change from primary to secondary school after Grade 4. This effect might be influenced by the teachers' classroom management since it is expected to vary between elementary and secondary school teachers who have different educational backgrounds. Teachers' classroom management is an important variable for modelling lesson quality because it

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influences learning outcomes. As numerous references show, classroom management is directly associated with the level of students' performance and improvement. The present study condenses the existing framework of classroom management into a measurable definition with special regard to physics-specific aspects. Multi-perspective analyses of 114 physics lessons have been computed by considering both student and teacher data (pre and post) as well as video analyses for a more objective view. The results not only show significant influences of classroom management on student outcomes, but also indicate significant differences in classroom management of teachers in elementary and secondary education in Germany.

S11.3.4 Students' Interest in Chemistry - Today and Twenty Years Ago

Wolfgang K. Graeber, University of Kiel, Germany, wgraeber@ipn.uni-kiel.de

ABSTRACT: Together with many other authors we believe that developing interest in a subject is one important pre-condition for learning as well as an important goal for learning with regard to life-long learning, out-of-school behaviour and choice of profession. These were reasons which led us since the 1970ies to do intense study into pupils' interest in physics and chemistry and which variables influence that interest. This contribution focuses on the definition of interest, the relationship between factors like achievement, gender, relevance, curriculum, teacher and classroom climate and students' interest, what altogether will form the base for curricula and methodical recommendations. Questionnaire data from 1990 and 2008 of German high school students (grades 8 to 10) are analyzed with SPSS and Lisrel and descriptive results as well as those from factor-, item-, and path analysis will be presented. The calculated model (path analysis) shows the significant interrelationship of cognitive, emotional and value related factors with interest. The descriptive data show interesting gender related differences and development during the past 20 years.

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

S11.4 Conceptual Reasoning and Problem Solving in Physics

10:15am – 11:45am, Curacao 5

President: Grant E. Gardner, East Carolina University

S11.4.1 Using Students' Rating of Problem Similarity to Assess Course-integrated Contrasts and Compare Activities

Frances A. Mateycik, Penn State Altoona, fam13@psu.edu

Sean T. Elward, Penn State Altoona

ABSTRACT: Recognizing the deep structure differences and similarities between problems is essential for conceptual schema adaptation. Students in an algebra-based physics course were asked to explicitly compare and contrast physical cases in both homework and laboratory settings. Students were required to communicate similarities and differences between selected problems on each weekly homework assignment and also collaboratively communicate similarities and differences between specific laboratory observations and specific homework problems. Data were collected to assess students' emphasis on deep-structure at the beginning and end of the spring 2010 semester using similarity ratings surveys. Each survey asked students to rate the similarities between eight pairs of problems of varying similarity, and then defend each of their ratings with a two or three-sentence statement. This paper will present a comparison of students similarity ratings scores before and after treatment. Students performance on all laboratory assignments and in-class examinations were also collected to determine if there existed any significant correlation between performance and similarity ratings.

S11.4.2 Students' Understanding of Mathematical Integration in Physics Problems Using Graphical and Algebraic Representations

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

Dong-Hai Nguyen, Kansas State University

Elizabeth Gire, University of Memphis

ABSTRACT: We report on a study to explore students' understanding of integration as an accumulation process in the context of physics problems in graphical and algebraic representations. Twenty students in a calculus-based physics

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course were interviewed several times during the semester. In these interviews, students solved several physics problems in which information was provided in graphical and algebraic representations. A facilitator interacted with the student to explore his/her reasoning and to provide hints whenever the student was not able to proceed. Here we analyze students' performance on several integration tasks embedded in the interview problems on work and energy. To solve these problems, students had to calculate work done by a force using the concept of integration as the area under the curve in the graphical representation or as the algebraic integral of force function in the algebraic representation. We analyzed students ideas of integration using the theoretical framework of concept projection and found that although most of the students were able to recognize the use of integration, calculate the area under the curve and compute the integral correctly, only one student indicated an understanding of the accumulating process underlying those calculations.

S11.4.3 Comparing Physics Content and Representations across Four Introductory College Physics Textbooks

Suzanne M. Donnelly, Longwood University, donnellysm@longwood.edu

ABSTRACT: This study features a comparative descriptive analysis of the physics content and representations surrounding the first law of thermodynamics as presented in four widely used introductory college physics textbooks representing each of four physics textbook categories (calculus-based, algebra/trigonometry-based, conceptual, and technical/applied). Introducing and employing a newly developed theoretical framework, multimodal generative learning theory (MGLT), an analysis of the multimodal characteristics of textbook and multimedia representations of physics principles was conducted. The modal affordances of each respective textbook's representations were identified, characterized, and compared in the context of their support of problem-solving skills and strategies, providing evidence that both the science content associated with the first law of thermodynamics and the types of representations used to portray that content differ across the four textbook categories.

S11.4.4 Prior Knowledge and Reflective Reasoning: To What Extent Do College Science Students' Preconceptions Bias Their Reasoning Processes as They Solve Conceptual Physics Problems?

Ava A. Zeineddin, Wayne State University, eb8533@wayne.edu

ABSTRACT: The ability of evaluating evidence independently of prior beliefs is a main characteristic of advanced scientific reasoning. Students' failure to question or reflect on their prior knowledge or beliefs is a potential cause of their inadequate or biased reasoning. This study examined the extent to which preconceptions held by college science students negatively influenced (or biased) their reasoning processes as they solved conceptual problems in hydrostatics. Results showed weaknesses in participants' reflective reasoning processes inhibiting successful problem solving.

Strand 6: Science Learning in Informal Contexts

S11.5 Maximising the Impact of Science Outreach on Students' Attitudes Towards Science and Careers in Science

10:15am – 11:45am, Curacao 6

Discussant: Leonie Rennie, Curtin University of Technology

ABSTRACT: The research presented in this paper set addresses the problem of falling student enrolments in science educational programs and the sustainability of global science expertise that requires highly skilled and knowledgeable professionals and technicians. Specifically, the papers examine the role that outreach programs can have on high school students' attitudes towards science, science subject selection, and careers in science. The four papers examine three outreach programs including a careers guest speaker program, an Olympiad summer camp, and a hands-on science and engineering competition. The methods include both quantitative and qualitative approaches. Each paper employs a different theoretical perspective to frame the research and discuss the findings. The first paper uses an 'alignment' perspective to consider the impact of the degree of alignment between the expectations of outreach providers and outreach consumers. The second paper uses an 'identity' perspective to understand how science outreach might influence students' views of themselves and their views of scientists. The third paper utilises a 'passion' perspective to consider how a summer science camp impacts high achieving students. Finally, the fourth paper uses an 'impact' perspective to critically analyse different methodologies used to evaluate outreach programs.

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S11.5.1 Student and Teacher Feedback on a Science Careers Outreach Program: An 'Alignment' Perspective

Sophia Bickford, University of Western Australia, bickfs01@student.uwa.edu.au

Nancy Longnecker, University of Western Australia

Grady Venville, University of Western Australia

S11.5.2 The Impact of a Science Careers Outreach Program on Students: An 'Identity' Perspective

Grady Venville, University of Western Australia

Nancy Longnecker, University of Western Australia

Leonie Rennie, Curtin University of Technology

S11.5.3 The Olympiad Informal Science Experience: A 'Passion' Perspective

Mary Oliver, University of Western Australia

Grady Venville, University of Western Australia

S11.5.4 Evaluating School Focused Science Outreach: An 'Impact' Perspective

Kira Husher, The University of Newcastle

John O'Connor, The University of Newcastle

Sid Bourke, The University of Newcastle

Adrian Page, The University of Newcastle

Strand 7: Pre-service Science Teacher Education

S11.6 Preservice Teachers Conceptions and Perceptions of Science Practices and Curriculum

10:15am – 11:45am, Curacao 7

President: Meredith A. Park Rogers, Indiana University

S11.6.1 Concept-Focused Inquiry (CFI): Using a Theory of Instruction to Enhance Understanding of Constructivist-based Teaching

Austin M. Hitt, Coastal Carolina University, amhitt@coastal.edu

Denise B. Forrest, Coastal Carolina University

ABSTRACT: It is not uncommon for science teacher educators to express frustration about preservice teachers' reluctance to plan and implement constructivist-based lessons. Alternatively, preservice teachers express dissatisfaction with their science methods courses. Preservice teachers commonly enter a science methods course with the expectation they will learn how to teach science. Instead they can become frustrated because they are uncertain how they integrate and utilize learning theories and instructional techniques into their teaching. One potentially viable approach for bridging the gap between theory and practice is to train preservice science teachers to use an explicit theory of instruction as outlined by Jerome Bruner in *The Process of Education* (1966). The purpose of this presentation is to introduce a general theory of science instruction called Concept-Focused Inquiry (CFI) and present empirical research on the impact of using CFI to train secondary preservice teachers. First, the development and the supporting research for CFI will be summarized. Second, the impact of the CFI on preservice science teachers' perceptions of science and science teaching will be presented. Third, the impact on the level of inquiry used in the preservice science teachers lesson plans will be discussed.

S11.6.2 Who Has Control Over the Science Curriculum?

Felicia Moore-Mensah, Columbia University, moorefe@tc.columbia.edu

Tara O'Neill, University of Hawaii, Manoa

ABSTRACT: This study reports findings from elementary preservice teachers who participated in a semester-long teacher education partnership between New York City (NYC) and Hawai'i. A Ning (an internet based networking site) blog group was set up for the NYC-Oahu partnership and used for extended classroom conversations and collaborations. This

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particular study focuses on a series of blog postings related to control of the curriculum. The findings of the study reveal that the preservice teachers see curriculum and science standards (used interchangeably) as a guide, but find them to be vague; they feel that teachers can creatively use the standards; and that teachers actually have little or no control over the curriculum/standards that they have to teach. Finally, only a few of the preservice teachers note that students have control over the curriculum. As national debates continue about curriculum and standards, this study will be of interest to NARST attendees who are engaged in conversations about standards—national, state and local—for the preparation and professional development of teachers in urban classrooms.

S11.6.3 Pre-service Elementary Teachers' Conceptions of Inquiry: Classroom Scenarios vs. Classroom Observations

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

Nam-Hwa Kang, Oregon State University

Teresa M. Higgins, University of Northern Colorado

ABSTRACT: This study investigated whether pre-service elementary teachers' entering conceptions of inquiry included the multifaceted aspects of inquiry represented in the Standards (NRC, 1996, 2000) by using classroom scenarios and how their conceptions of inquiry resonate in their reflection on real science classrooms. The survey data, which contained nine short classroom scenarios, was collected from 172 pre-service elementary teachers. In addition, 20 reflection papers about science inquiry classrooms were randomly chosen for in-depth analysis. The data was analyzed both qualitatively and quantitatively. The findings from the classroom scenarios demonstrated that pre-service elementary teachers (1) did not perceive the "understanding about inquiry" but only identify abilities to do inquiry as a part of inquiry teaching, (2) focused on the "process" skills rather than developing "cognitive abilities" emphasized in the Standards, (3) did not recognize variations of inquiry activities, and (4) believed that hands-on activities promised inquiry learning. In depth analysis of the pre-service elementary teachers' reflections on real classrooms demonstrated that their conceptions of inquiry as knowledge pieces (diSessa, 1993) were activated differently at the ideal level and at the practical level. Implications for elementary teacher preparation programs are suggested.

Strand 8: In-service Science Teacher Education

S11.7 Teachers and Inquiry

10:15am – 11:45am, Curacao 8

President: Peter Meyerson, College of Education & Human Services

S11.7.1 Reflections on Self Classroom Videos and Student's Perceptions

An-Shun Yu, National Changhua University of Education, ncueanshun@gmail.com

Kun-Yi Shih, National Changhua University of Education

Hsin-Chuan Ho, National Changhua University of Education

Kuo-Hua Wang, National Changhua University of Education

ABSTRACT: Reflection is one of effective ways of professional development. The purpose of the study was to assess effectiveness of reflections on self classroom videos and student perceptions of teaching on professional development of science teacher. Case study method is adopted in this study. One experienced science teacher and her science class including twenty-seven 8th grade students are invited in the study. The project was implemented about 3 months. A network-based camera system, named the NCS, is developed for distance classroom observation and for classroom video-tapings. The case teacher participated in our project, received information on professional development, then asked for preparing, practice, and reflection on her science teachings during process of the project. The research tools include Student Perceptions of Teacher's Knowledge (SPOTK) Scale, teaching video-tapes, teacher's reflection diary, and interview transcripts. The results showed that reflections on self classroom videos and reflections on students' perceptions of instruction are effective ways for professional growth. In addition, reflections promote teacher's change in science teaching practices. Implications are discussed in the paper.

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S11.7.2 The Effect of Professional Development on Teachers' Beliefs and Pedagogical Content Knowledge for Scientific Argumentation

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

Amanda M. Knight, Boston College

ABSTRACT: One of the hallmarks of science and science education is the production of new knowledge about the natural world through objective argument and critique. Teachers' understanding of argumentation and beliefs about the role of argumentation in science teaching impact how they incorporate this important scientific practice into science classrooms. This study examined how a professional development workshop series grounded in authentic practice impacted seventy elementary, middle and high school teachers' pedagogical content knowledge (PCK) and beliefs about scientific argumentation. Data sources included pre and post surveys, videotapes of the workshops, artifacts produced by the teachers, and samples of student writing. Results from the analysis suggest that teachers' understanding of reasoning improved as well as their beliefs exhibited a shift towards argumentation in terms of the underlying purpose of science teaching. Yet teachers demonstrated a limited understanding of dialogic interactions during classroom discussions and few teachers considered the role of alternative explanations. Our study suggests that viewing science as a social process that includes considering and debating alternative explanations is a challenge not only for students, but also their teachers.

S11.7.3 The Uses of Student Learning Data in Collaborative Teacher Inquiry

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

David Slavit, Washington State University Vancouver

Angie Deuel, Washington State University Vancouver

ABSTRACT: Science and mathematics teachers are increasingly involved in various types of collaborative inquiry groups, such as professional learning communities (PLCs), video clubs, and lesson study groups. In a collaborative inquiry process, teachers work with student learning data to better understand teaching, learning, and their content-based learning expectations. This presentation is based upon five years of research with seven secondary science and mathematics PLCs. Using a grounded theory methodology, we developed descriptions of the four phases of a data process these teachers employed as they explored potentially informative data sources, identified and/or constructed data collection tools, analyzed data, and derived implications for future practice. We also present four distinct ways in which teachers used data in their PLC meetings: 1) distributed data, 2) referenced data, 3) data in absentia, and 4) anecdotal data. We also draw from a quantitative analysis of the amount of time teachers in PLCs spent in these different phases and the ways they used data to explore the relationship between these factors and a teacher group's epistemological stance toward student learning data.

Strand 10: Curriculum, Evaluation, and Assessment

S11.8 Related Paper Set - Employing Sociocultural Frameworks In Program Evaluation Design: Exploring The Challenges And Benefits For Internal And External Evaluation

10:15am – 11:45am, Bonaire 1

Discussant: Yushaneen Wilson, University of Pennsylvania

ABSTRACT: This collection of studies provides evidence of how sociocultural frameworks employed in program evaluation design are providing insights and directions for both re-thinking the relationship between internal and external evaluation components, and for improving professional development for science teachers. The design of program evaluations have changed over the last two decades, becoming increasingly complex in both breadth and depth, incorporating mixed-methodologies for collecting data and introducing various theoretical frameworks from which to evaluate the data. In this paper set, we examine the effects of implementing a sociocultural perspective, informed by Fourth Generation Evaluation (Guba & Lincoln, 1989), as the organizing feature of a program evaluation for a large Math Science Partnership (MSP) funded by the National Science Foundation (NSF). The Science Teacher Institute (STI) was developed to provide inquiry-based, content-focused, extended professional development to in-service middle and high school science teachers. The papers in this presentation illustrate a diverse range of research foci within the

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context of the evaluation of the program and offers findings that are significant for science teachers and teacher educators, as well as provide evidence that can inform program development and evaluation for future MSPs and for science teacher education policy developers locally and globally.

S11.8.1 One Person's Internal Evaluation is Another's Design Study: What Internal Evaluation Brings to Professional Education Programs in Science

Sonya N. Martin, Drexel University, sonya.martin@drexel.edu
Catherine E. Milne, New York University

S11.8.2 Facilitating Responsive Science Teacher Education: Professional Development as Embedded in Teachers' Everyday Practices and Concerns

Christina Siry, University of Luxembourg

S11.8.3 The Role of e-Portfolios in Documenting Teacher Leadership

Rachel Ruggirello, Washington University in St. Louis

S11.8.4 Program and Policy Changes for Teachers' Professional Development Based on Evaluation Data

Jane Butler Kahle, Miami University
Kathryn Scantlebury, University of Delaware
Yue Li, Miami University

Strand 11: Cultural, Social, and Gender Issues

S11.9 Students' Attitudes toward and Aspirations in Science: Ethnicity, Religion, and Gender Effects

10:15am – 11:45am, Bonaire 2

Presider: Cassie F. Quigley, Clemson University

S11.9 .1 (Re)thinking the Influence of Social Class: Science-related Career Aspirations amongst Minority Ethnic Students aged 11-14 in England

Billy Wong, King's College London, billy.b.wong@kcl.ac.uk

ABSTRACT: In sociology, socioeconomic background is regarded as a key site for the reproduction of social and educational inequalities. As science and science-related careers were traditionally viewed as privileges for the elite (e.g. 'White middle class men'), certain groups of people, such as women, working class and minority ethnic groups, have traditionally been disadvantaged with limited access to scientific careers. This paper focuses on the influence of social class in shaping science-related career aspirations, and it is argued that discourses within minority ethnic families can facilitate science-related career aspirations even when students are from 'working class' backgrounds. Data in this paper come from an ongoing doctoral study looking into the science and career aspirations of minority ethnic students aged 11-14 in England, where 46 students aged 11-14 from British-African Caribbean, British-Pakistani, British Bangladeshi, British-Indian and British-Chinese ethnic backgrounds in London were interviewed on their perceptions and aspirations in science.

S11.9.2 An Investigation of Boys' and Girls' Affective Learning in Science and Big-Five Traits

Zuway-R Hong, National Sun Yat-sen University, a3803429@ms49.hinet.net
Huann-Shyang Lin, National Sun Yat-sen University

ABSTRACT: Abstract 170 words This study investigated the significant differences and predictors of Taiwan's elementary and secondary school students' affective learning in science and Big-Five traits. Nine hundred and twenty-two elementary students and 1954 secondary students completed the School Student Questionnaire in 2008. Factor Analyses, correlation analyses, ANOVAs and regressions were used to compare the similarity and differences among boys and girls in different school levels. The initial findings were as follows: Girls had better interest in science and peer

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relations at science class and made more contribution toward team members than boys across all school levels. As students advanced through school, students' Big-five traits of Conscientiousness and Openness sharply declined; students' Neuroticism dramatically increased. Elementary school and senior high school students had significantly higher total scores on affective learning in science than those of vocational high and junior high school students. Moreover, the traits of Agreeableness, Extraversion, and Conscientiousness were the most powerful and significant predictors on students' affective learning in science. Lastly, we discussed the implications of these findings on classroom instruction. Key words: Cross-section study; affective learning in science; Big -Five Traits; elementary and secondary school students, gender differences

S11.9.3 Science-related Aspirations among Elementary School Children: Modeling Early Influences

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

Jonathan F. Osborne, Stanford University

Louise Archer, King's College London

Justin Dillon, King's College London

Beatrice Willis, King's College London

Billy Wong, King's College London

ABSTRACT: Students' lack of interest in studying science and in science-related careers is a topic of global concern. In response, the ASPIRES (Science Aspirations and Careers: Age 10-14) longitudinal study is exploring the development of students' educational and occupational aspirations over time. In the first phase of the project, a questionnaire exploring students' aspirations and interests was completed by over 9000 primary school students across England. Principal components analysis and Cronbach's alpha revealed unidimensional components whose reliability was acceptable. This paper focuses on the outcomes of multilevel modeling analyses, which shows that it is factors such as parental attitudes to science, experience of school science, and ethnicity that are most strongly related to students' aspirations in science. Qualitative data obtained from interviews with students and parents provide further insight into the questionnaire findings.

S11.9.4 Muslim Students' Conceptions of Evolution

Anila Asghar, McGill University, anila.asghar@mcgill.ca

Saouma B. Boujaoude, American University of Beirut

Jason R. Wiles, Syracuse University

Brian Alters, McGill University

ABSTRACT: Biological evolution continues to be politically controversial in many countries, primarily because of its perceived conflict with particular religious beliefs and doctrines. Alarming, many of the recent cases are centered on Islamic creationism, and the situation could grow even worse. This study examines the religious and scientific understandings of Muslim secondary students from two Middle Eastern cultural contexts; a context in which the overwhelming majority of the population is Muslim (Egypt) and another in which there is a sizeable Christian community (Lebanon). Survey data were collected from 162 Egyptian and 629 Lebanese students followed up by interviews with 30 students. The internal reliability of the survey was calculated and Cronbach's alpha was 0.76 for the Egyptian survey and 0.82 for the Lebanese survey. Results show that many students exhibited misconceptions about scientific evolution and the nature of theories. Around 53% of Lebanese and 59% of Egyptian students reported that their religious beliefs influence their positions regarding evolution. Many students thought that the theory of evolution is not scientifically supported and rejected evolution because it contradicted their religious beliefs about the creation of life. This study informs science teachers about how Muslim students might respond to evolution in their classes.

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Strand 14: Environmental Education

S11.10 Symposium - Theorizing Inquiry, Science Education, and Professional Development from Indigenous Hawaiian and Aboriginal Taiwanese Perspectives

10:15am – 11:45am, Bonaire 5

Presider: Pauline W. U. Chinn, University of Hawaii at Manoa

Discussant: Huei Lee, National Dong Hwa University, Hualien, Taiwan

Presenters:

Alyson Barrows, University of Hawaii at Manoa

Huihui Kanahale-Mossman, University of Hawaii at Manoa

Michelle M. Kapana-Baird, University of Hawaii at Manoa

Sabra Kauka, University of Hawaii at Manoa

Gandharva M. Ross, University of Hawaii at Manoa

Kellie Kong, University of Hawaii at Manoa

Chiung-Fen Yen, Providence University, Taichung, Taiwan

Su-Fen Lin, Providence University, Taichung, Taiwan

ABSTRACT: Despite developing extensive ecological knowledge through activities and values oriented to subsistence lifestyles, Indigenous Hawaiians and Taiwanese are underrepresented in science courses and careers. Contributors to this symposium present Indigenous science education from multiple perspectives as: Indigenous evaluator and teachers, teachers of Indigenous students, researchers exploring Indigenous inquiry, researcher of social networks, and non-Indigenous researchers seeking to develop science education for aboriginal Taiwanese. Hawai'i's researchers found Indigenous narratives, identity, sense of place, and beginning with Indigenous practices and understandings supported Indigenous inquiry oriented to sustainability: mlama, care for places and kuleana, rights to and responsibility for resources. The Indigenous evaluator viewed science educators as progressing through 5 levels of cultural expertise, beginning with use of culturally appropriate "lay" language to being in the world in culturally valid ways. The role of technology in maintaining a diverse community of learners is examined. Taiwanese researchers focus on Bunun culture as they seek to understand how Taiwanese aboriginal practices, values, and ways of being in the world may inform an Indigenous science education despite rapid societal change and dominant Han culture. Implications for more inclusive science education are discussed.

Publications Advisory Committee Sponsored Session

S12.1 Symposium - Managing the Digital Intellectual Life(stream) of a 21st Century Science Education Scholar

1:00pm – 2:30pm, Antigua 1

Presider: Carla Zembal-Saul, Penn State University

Presenters:

Scott P. Mcdonald, Penn State University

Eric N. Wiebe, North Carolina State University

ABSTRACT: The way scholars in science education and members of NARST do their jobs has not changed fundamentally, but the process of participating in the intellectual community is being changed by the same tools that are reshaping social interactions. This session is organized into three parts and will describe some of the tools currently available to science education scholars to organize their digital lives in ways that support their intellectual work. The first part of the session will focus on accessing resources using RSS feeds from journals and intelligent searches from databases that allow scholars to easily find the journal articles and other resources they are interested in reading. The second part of the session will deal with the organization and management of intellectual resources. A number of tools have emerged that allow for tagging, grouping, reading and note-taking around the resources that have been gathered. These tools also allow groups to come together to do collaborative scholarly work at a distance. The final part of the session will deal with citations and bibliographic management, the tools for which have become increasingly powerful and focused on the support of collaborative scholarship.

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Strand 1: Science Learning, Understanding and Conceptual Change

S12.2 Related Paper Set - Metacognition in Science Education: Theory and Practice

1:00pm – 2:30pm, Curacao 1

Discussant: Larry Yore, University of Victoria

ABSTRACT: Researchers define metacognition as awareness of and reflection upon one's own cognitive process. It induces self-regulation and conscious coordination of learning tasks (Flavell 1976, 1981). Metacognition is knowledge about peoples' cognition, cognitive tasks, strategies for solving learning tasks, skills for monitoring one's cognitive activities, awareness of cognitive processes, and management of learning processes. The goal of this paper set is to analyze metacognition in science education and discuss trends in current research. We describe theoretical and research-based trends concerning metacognition in science education, including physics, chemistry, biology and environmental education. We attempt to resolve the fuzziness and mismatches in the various definitions of metacognition. Metacognitive knowledge refers to the knowledge about the cognitive system, while metacognitive skills concern the regulation of cognitive processes. The historical roots, the nature of processes involved, the development and acquisition, and assessment methods are discussed for both concepts. Building on the literature, we present examples of studies regarding the interrelationships between the cognitive and metacognitive levels. Finally, the role of metacognitive skills in science education is discussed from the perspective of how metacognitive skills are enacted in four types of learning processes: reading text, problem solving, inquiry learning, and writing.

S12.2.1 Overview and Discussion of the Forthcoming Book Metacognition in Science Education: Trends in Current Research

Anat Zohar, Hebrew University, msazohar@mscc.huji.ac.il

S12.2.2 Metacognition and a Naive View of Reading Science

Stephen P. Norris, University of Alberta

Linda M. Phillips, University of Alberta

S12.2.3 A Metacognitive Tool and Its Effect on Complex Questions Posed by High School Chemistry Majors

Yehudit J. Dori, Technion, Israel Institute of Technology

Orit Herscovitz, Technion, Israel Institute of Technology

Osnat Eldar, Weizmann Institute of Science

Miky Ronen, Holon Institute of Technology

Bat-Sheva Eylon, Weizmann Institute of Science

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S12.3 Related Paper Set - Contemporary Perspectives on Genetics Learning: Environments for Supporting Student Learning of Genetics and Scientific Practices

1:00pm – 2:30pm, Curacao 2

ABSTRACT: Innovation and discovery in genetics research burgeons today as new technologies afford novel approaches to inquiry and analysis. In addition, personal genetic information is available to the general public through health professional and for-profit companies and it can be a powerful tool in life decisions. Despite the power of genetic research and the promise of genetic information for personal decision making, there is a lack of public understanding of genetics concepts and the scientific practices behind them (Lewis & Wood-Robinson, 2000). This related paper set seeks to gain a shared understanding on discipline-specific learning in genetics by presenting two leading research agendas: (a) exploration of genetics learning through developmentally-rooted and sustained learning progressions, and (b) investigations into how learning environments and pedagogical practices can support student learning through participating in the practices of scientists.

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S12.3.1 Characterizing Conceptual Dependencies in the Development of Students' Understandings of Classical and Molecular Genetics

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

Nicole Shea, Rutgers University

S12.3.2 Problem-solving in an Authentic Learning Environment: The use of Bioinformatics Tools and Databases for Learning Genetics and Biotechnology

Yossy Machluf, Weizmann Institute of Science

Carmit Shpalter, Weizmann Institute of Science

Orna Dahan, Weizmann Institute of Science

Amir Mitchell, Weizmann Institute of Science

Anat Yarden, Weizmann Institute of Science

S12.3.3 Examining Student Understanding of the Genome Sciences: Supporting Connections Between Science and Everyday Life

Katie Van Horne, University of Washington

Hiroki Oura, University of Washington

Andrew W. Shouse, University of Washington

Philip Bell, University of Washington

S12.3.4 Learning Genetics of Human Behavior and Disease Through Exploring Real Scientific Data

Hiroki Oura, University of Washington

Katie Van Horne, University of Washington

Andrew W. Shouse, University of Washington

Philip Bell, University of Washington

S12.3.5 Using Professional Development to Support Classroom Discussions in Genetics and Genomics: Getting Students Talking

Nonye Alozie, Wayne State University

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

S12.4 Related Paper Set - Examinations of the Beliefs of Teachers: Exploring a Complex Construct

1:00pm – 2:30pm, Curacao 4

ABSTRACT: The importance of teacher beliefs has been emphasized in the research literature over the last few decades. Those who study teacher beliefs consider them to be personal constructs that are essential to a teacher's practice, as they guide decisions, influence classroom management, and impact the representation of content in the classroom. Given the relationship of practice to beliefs, science teacher educators are concerned with the beliefs teachers hold, and work towards developing beliefs among science teachers that support reform-based practices. In this set of related research papers, we present four different studies that explore how beliefs and content knowledge interact, the impact of teacher beliefs on student learning and teacher practices, teacher beliefs during different professional development programs, and the beliefs of early career teachers. This paper set presents different approaches to beliefs research, and contributes to our ongoing discussion about the development of beliefs among secondary science teachers. It also offers practical implications for those who work with secondary science teachers.

S12.4.1 Relationships between Physics Teachers' Beliefs about Nature of Science, their General Educational Beliefs, and Self Reported Teaching Behaviour Purpose and Theoretical Framework

Nelleke A.H. Belo, ICLON Leiden University, nbelo@iclon.leidenuniv.nl

Jan H. Van Driel, ICLON Leiden University

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Nico Verloop, ICLON Leiden University

S12.4.2 Exploring the Beliefs of Persisting Secondary Science Teachers in General Induction Programs: A Longitudinal Study

Sissy Wong, University of Houston

Julie Luft, Arizona State University

S12.4.3 Context Based Science Education: Chemistry Teachers' Knowledge and Beliefs, and their Students' Learning Outcomes

Ineke Henze, ILS Radboud University

S12.4.4 Beliefs of Beginning Secondary Science Teachers Over Five Years: Stability and Change

Julie Luft, Arizona State University

Sissy Wong, University of Houston

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

S12.5 Learning Chemistry & Measurement Skills

1:00pm – 2:30pm, Curacao 5

Presider: Peter Meyerson, College of Education & Human Services

S12.5.1 Heuristic Reasoning: How do Students Make Decisions in Chemistry?

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

Lakeisha McClary, University of Arizona

ABSTRACT: The characterization of students' reasoning strategies is of central importance in the development of instructional strategies that foster meaningful learning. In particular, the identification of shortcut reasoning procedures (heuristics) used by students to reduce cognitive load can help us devise strategies to facilitate the development of more analytical ways of thinking. The central goal of this qualitative study was thus to investigate heuristic reasoning as used by college students, focusing our attention on their ability to predict the relative acid strength of chemical compounds represented using explicit composition and structural features. Our results indicated that many study participants relied heavily on one or more of the following heuristics to make most of their decisions: reduction, representativeness, and lexicographic. Despite having visual access to reach structural information about the substances included in each ranking task, many students relied on isolated composition features to make their decisions. Although the use of heuristics allowed students to simplify some components of the ranking tasks and generate correct responses, it often led them astray. Our results suggest the need for instructional interventions that explicitly develop students' abilities to monitor their thinking and evaluate the effectiveness of analytical versus heuristic reasoning strategies in different contexts.

S12.5.2 Measuring Volume of Tree: A Problem-driven, Modeling-based Lesson for Preservice Science Teachers

Ji Shen, University of Georgia, jishen@uga.edu

ABSTRACT: Measurement is an essential skill that students need to develop in both math and science classes. Broadly defined, carrying out a measurement task involves a complex set of processes such as recognizing the object to be measured, operationally defining variables of the object, obtaining and using appropriate measurement tools, calculating measurement results, reflecting on measurement procedures and results, identifying measurement errors, and representing and communicating measurement results to others. In this study I designed and implemented a unit on scientific measurement in which students need to measure the volume of a tree of their choice. Seventeen preservice middle school science teachers participated in the study and completed the task in five small groups. The data collected include audio recording of class and small group discussion, audio recording of student conversations when they carried out their tasks, individual written lab reports and other student artifacts. Careful analysis of these data revealed that these students had interesting and nuanced measurement strategies, but lacked basic understanding of some

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measurement procedures and concepts. It was also found that many students did not make sense of their measurement results.

S12.5.3 College Students' Understanding of the Particulate Nature of Matter Across Reaction Types

James M. Nyachwaya, University of Minnesota, Twin Cities, nyach002@umn.edu

Gillian H. Roehrig, University of Minnesota, Twin Cities

Anne L. Kern, University of Idaho

Nathan Wood, North Dakota State University

Jamie Schneider, University of Wisconsin, River Falls

Abdi-Rizak Mohamed, University of Minnesota, Twin Cities

ABSTRACT: Chemistry instruction and assessment have traditionally focused on the symbolic realm, where chemical and mathematical symbols and equations are used. This approach assumes that the ability to solve symbolic problems implies conceptual understanding of chemistry. A number of studies have however shown that students who are successful at solving mathematical and symbolic problems in chemistry don't necessarily understand the chemistry concepts involved. This qualitative study looks at college students' representations of three reactions at the particulate level. Data in the form of student drawings was collected from 67-75 freshman chemistry students. While almost all students were able to correctly balance the given chemical equations, only a small percentage was able to draw conceptually appropriate representations of the reactions at the particulate level across three reactions. Looking at the drawings, we can speculate on the fundamental chemistry concepts that students seem to be lacking. Our analysis reveals struggles with the nature and differences between ionic and covalent bonding, the meaning of coefficients and subscripts, polyatomic ions, meaning of state symbols/physical states and the ability to navigate between levels of representation. The results of this study are a backdrop for further research on how and where such struggles begin.

S12.5.4 Exploring Alternative Conceptions on Molecular Geometry in Postsecondary Chemistry Education

Caroline Cormier, Université de Montréal, caroline.cormier.1@umontreal.ca

Jesús Vázquez-Abad, Université de Montréal

ABSTRACT: Alternative conceptions are mental constructs that students have of a concept that are different from or inconsistent with the scientific definition. The presence of alternative conceptions on basic concepts can have a negative impact on the learning of more complex models and theories at a higher education level. Some alternative conceptions are particularly stable and still found in students' explanations even if they are at an advanced level. Molecular geometry is a fundamental topic in postsecondary chemistry education. Correct evaluation of the shape of a molecule is essential to predict its polarity and, in turn, several properties such as reactivity and solubility. A particularly important upstream concept to molecular geometry is the atomic model. Alternative conceptions on the atomic model and the particulate nature of matter might lead to the development of alternative conceptions on molecular geometry. The present study is an exploratory qualitative research designed to generate hypotheses on the nature of conceptions about the atomic model and molecular geometry in postsecondary science students. The theoretical framework for the study, its design and methodology, and results from interviews with eight college students will be discussed in the presentation.

Strand 7: Pre-service Science Teacher Education

S12.6 Preservice Teachers' Learning of Scientific Practices

1:00pm – 2:30pm, Curacao 7

President: Cory T. Forbes, University of Iowa

S12.6.1 Qualities of Pre-Service Teachers' Classroom Questioning

Melissa L. Shirley, University of Louisville, melissa.shirley@louisville.edu

Stephanie B. Philipp, University of Louisville

ABSTRACT: Teachers use formative assessment (FA) strategies to identify student learning difficulties. One particular method used to reveal student understanding is the use of whole-class oral questioning. A number of aspects of

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questioning, including the use of higher cognitive level questions and provision of quality feedback, have been shown to increase student achievement and engagement. It remains unclear, however, how pre-service teachers (PST) acquire sophisticated questioning skills. This study provides an initial characterization of the depth and quality of middle and secondary PSTs' oral whole-class questioning practices. PST enrolled in a science methods course recorded and transcribed a brief segment of one of their lessons. This study examines those transcripts to identify features of questioning, including the frequency, depth, and cognitive level of questioning cycles. By identifying smaller assessment episodes with a transcribed lesson excerpt, we focus our attention on the particular teacher questions, student responses, and follow-up moves from the teacher as a line of probing is followed. Findings show that many questioning cycles were cursory and focused on low cognitive-level skills and knowledge. Potential interpretations of these data and implications for teacher preparation programs and for future research studies will be addressed in this presentation.

S12.6.2 Approximations of Practice in an Elementary Science Methods Course: Preservice Teachers Learning to Teach Investigations

Michele Nelson, Graduate Student, University of Michigan, mishmash@umich.edu

Elizabeth A. Davis, Associate Professor of Science Education, University of Michigan

ABSTRACT: Our study examined the ways in which preservice elementary teachers teach science lessons involving scientific investigations. To support preservice teachers in developing their science teaching skills, we have designed a series of increasingly complex and authentic "approximations of practice" (Grossman et al., 2009), or science teaching simulations, as methods course opportunities for learning to teach investigation lessons. Case studies of four focal preservice teachers revealed that in more supported approximations of practice, such as peer teaching, preservice teachers focused on the nuances of science teaching in smaller portions of investigation lessons. In these approximations, they also received real-time constructive feedback, which they used to evaluate and revise instructional approaches. In more complex and authentic approximations of practice, such as entire science lessons taught in local elementary classrooms, preservice teachers incorporated some, but not all, key components of science investigation lessons. Interviews with preservice teachers complemented enactment observations and revealed their rationales for choosing certain instructional practices. Our findings extend the literature on preservice elementary teacher learning and practice in the area of scientific investigations, provide a novel application of the approximation of practice framework in elementary science teacher education, and inform elementary science methods course design of practice-oriented learning opportunities. Reference cited: Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, 111(9).

S12.6.3 Providing a Conductive Learning Environment in Content Courses for Elementary Pre-service Teachers' Understanding of Scientific Modeling

James A. Hagerty, University of Michigan, haijs@umich.edu

Jean P. Krisch, University of Michigan

Elizabeth A. Davis, University of Michigan

ABSTRACT: Elementary pre-service teachers who enrolled in two different physics content courses engaged in varying levels of scientific modeling activities. The first course concentrated more on developing conceptual physics content knowledge for students who had no prior university physics experience. The students in the second course who had a prior university physics background engaged in purposeful inquiry-based modeling activities around conductivity plates. These students in the second course showed greater developed understandings of the physics content in their models as well as elements of greater capability to develop mechanistic explanations of other modeled phenomenon than students in the first course.

Strand 7: Pre-service Science Teacher Education

S12.7 Preservice Teachers' Understandings and Perceptions of the Nature of Science

1:00pm – 2:30pm, Bonaire 7

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

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S12.7.1 Just Bare-Bones Facts: STEM Career-Switchers' Perceptions the Role of the Nature of Science in Science Education

Marjee Chmiel, George Mason University, muchmiel@gmail.com

Burton Erin E. Peters, George Mason University

ABSTRACT: The purpose of this study is to characterize the perceived role Nature of Science knowledge (NOS) in science pedagogy as held by a population of career-switching, pre-service science teachers. The 17 participants in this study all have a previous professional background in science, technology, engineering, and math (STEM) careers and have completed a course in science teaching methods where NOS was addressed. Through an analysis of structured interviews triangulated with products demonstrating classroom pedagogy, this study demonstrates that STEM career switchers struggle with conflicts between NOS and their perceived bifurcated role as explainers and clarifiers of science for some students, and preparers of future scientists. Participants frequently conflated NOS as a teaching method to be employed as a means of differentiation for struggling students. This study explores the NOS understanding of an under-researched population of pre-service teachers (career-switchers with STEM backgrounds) and illuminates taxa of misconceptions that might arise around NOS in pre-service teachers. Furthermore, this study builds on existing research demonstrating that STEM educated professionals have a proclivity to interpret NOS through the lens of their own professional practice.

S12.7.2 Facilitating Preservice Teachers Understanding of Nature of Science Using Japanese Lesson Study

Amy V. Mcdowell, Douglas County Schools, Georgia, agilbert76@yahoo.com

Geeta Verma, Georgia State University

Lisa Martin-Hansen, Georgia State University

ABSTRACT: The purpose of this study was to explore preservice teachers' lived experiences in a lesson study focused on teaching and learning nature of science (NOS). The research questions guiding the study were (a) how do preservice teachers' understandings of NOS shift as a result of the lesson study experience?, and (b) how does the reflective practice that occurs in lesson study influence preservice teachers' transition of NOS tenets into classroom practice? The participants in this study represented a sample of graduate preservice teachers immersed in a reform based science preparation program. In the second semester, participants were placed in a practicum setting; where the exploration of the preservice teachers' teaching of NOS was supported through a modified lesson study framework. Data sources included the Views on Nature of Science – Form B (VNOS-b), interviews, and lesson study portfolios. Analysis of NOS understandings was guided by instruments found in literature associated with the VNOS-b (Lederman et al., 2002) and reflection (Ward & McCotter, 2004). Results showed successful transfer of NOS into classroom practice using the modified lesson study framework, with less success in the deepening of participants' NOS understandings.

S12.7.3 Investigating Elementary Pre-service Teachers' Understanding of Science in Our Everyday Lives through Student-created Videos

Blakely K. Tsurusaki, blakely.tsurusaki@gmail.com

John Lockhart

ABSTRACT: This study investigated elementary pre-service teachers' (PSTs) ideas about what science is, and how people experience science in their everyday lives, as portrayed in 34 videos that the PSTs created for their elementary science methods courses at two universities in the Northwest United States. We analyzed the content discussed in the video (e.g., plants, solar system), the extent that PSTs referenced and made use of process skills in elaborating their understanding of science, and whether the PSTs made use of inquiry in their videos. The majority of PSTs showed science as facts, nature, and technological products (e.g., products such as cell phones, light bulbs, mouthwash), implying that science is about products for human consumption and enjoyment. Nearly all videos showed the results of science, products and content knowledge (facts), rather than the process of science. Few videos demonstrated science as inquiry, or a process by which we create knowledge. The results of this study characterize dominant views of science PSTs hold, and we conclude with thoughts on some ways to help shift their paradigms.

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S12.7.4 Exploring the Use of Lesson Study to Develop Elementary Preservice Teachers' PCK for NOS

Khemmawadee Pongsanon, Indiana University, kpongsan@indiana.edu

Valarie L. Akerson, Indiana University

Meredith A. Park Rogers, Indiana University

Ingrid S. Weiland, Indiana University

ABSTRACT: This case study explores the use of a modified version of Japanese Lesson Study, which we implemented during field experience. This version of lesson study acted as a kind of CoP to support our preservice elementary teachers with developing their PCK for teaching NOS. Six female preservice teachers who enrolled in a science methods course clustered with an early field experience participated in this study. As a team, they developed mini unit of five science lessons on the topic of "Models and Designs" which they taught to a 5th grade class. A content analysis method was used to analyze the videos of the taught lessons and the lesson study following each lesson, which is our primary data source. Our findings revealed that there is no correlation between the kind of NOS discussed in the lesson study sessions and the lessons taught in the classrooms the following week, BUT there is still an increase in the amount of NOS taught in the lessons each week. This result indicates the possibility of lesson study having some influence on the PSTs PCK for teaching NOS, so some modifications to our lesson study format may result in stronger correlations.

Strand 8: In-service Science Teacher Education

S12.8 Teacher Beliefs

1:00pm – 2:30pm, Curacao 8

Presider: Mehmet Fatih Tasar, Gazi Universitesi

S12.8.1 Sociocultural Contexts of Science Teachers' Beliefs and Practices: Teachers' Perspective

Nasser Mansour, University of Exeter, n.mansour@ex.ac.uk

ABSTRACT: A growing body of research argues that teachers' beliefs and practices should be studied within the sociocultural contexts of their work because the relationship between their beliefs and practices is both complex and context-dependent. There is a need for further research in this area in understudied contexts such as developing countries, in order to promote effective education in schools and the professional development of teachers. This paper argues that if this "black box" of sociocultural contexts which have embedded science teachers is better understood, it may be possible to identify specific aspects of these contexts related to educational organizations that act as supports or barriers to pedagogical reform or implementing innovations in science education. Consequently, the main purpose of this study is to explore the sociocultural contexts of ten Egyptian science teachers and to what extent these sociocultural contexts help to understanding teachers' pedagogical beliefs and practices. This paper, by utilizing a multi-grounded theory approach and qualitative methods, revealed a variety of sociocultural contexts that are related to teachers' pedagogical beliefs and practices.

S12.8.2 School and Teacher Factors as Contributors to the Effectiveness of an Elementary-Level Professional Development Program

Dina Drits, University of Utah, dina.drits@utah.edu

Louisa Stark, University of Utah

ABSTRACT: The inquiry practices, inquiry beliefs, and physical science content knowledge of fifteen fourth through sixth-grade teachers from three low-performing elementary schools were examined in this study. A mixed model methodology was used to assess the effects of the elementary school context and individual/teacher factors on teachers' practice, beliefs, and content knowledge in the year following a successful reform-based science professional development program. Results indicate that a combination of school-level and teacher-level factors was essential to promote the changes experienced by teachers during the professional development program. The key school-level factor is support and/or mentorship from same-grade teams in teaching science through inquiry, which outranked the importance of school principal prioritization of science. The key individual-level factors for continued growth in inquiry practice are a willingness to change in fundamental ways and enjoyment of science as a subject. The findings from this

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study will inform the science education, policy, organizational, and professional development literature bases about the types of supports and resources upper elementary teachers require in their school context in order to maintain or enhance professional development experiences. This study will also benefit the NARST community through its methodological approach of using a mixed model and longitudinal design.

S12.8.3 Exploring the Role of Context in Shaping Indian Science Teachers' Orientations

Vanashri Nargund-Joshi, Indiana University, Bloomington, vnargund@indiana.edu

Meredith Nargund, Indiana University, Bloomington

ABSTRACT: The relationship between orientations and the knowledge components of pedagogical content knowledge (PCK) is a two-way street but can often be constrained by additional factors, such as the topic being taught, the context in which the teaching is occurring, and a teacher's general pedagogical knowledge (Abell, 2007). In this study we were interested in exploring to what extent the context one teaches in shapes their orientation(s) for teaching science. The context for this study is India and includes six 8th-10th grade science teachers with a range of teaching experience from 2-28 years. Data sources included classroom observations and a structured interview using a card-sort activity (Friedrichsen & Dana, 2003). We found each teacher held multiple orientations, some that were dominant and others that were more hidden in the background. Influencing contextual factors often mentioned included: parental pressure, the standardized testing system, lack of professional development, and an insufficient understanding of how students learn particular science concepts (i.e., PCK). In comparing and contrasting the teachers' orientation profiles, it was evident PD is needed to support the teachers' in modifying their orientations and practice to align with the goals of reform. Implications for designing PD to support such needs are discussed.

S12.8.4 The Impact of Research Experience for Teachers (RET) Professional Development Programs on Teacher Beliefs and Practice

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

Katrina Roseler, The Florida State University

Barry Golden, The Florida State University

Sherry A. Southerland, The Florida State University

ABSTRACT: In hopes of shaping teacher beliefs and enhancing the practice of inquiry teaching, Research Experiences for Teachers (RETs) have emerged as a popular approach for providing professional development with these goals. These experiences can vary in specific designs, but the overall aim is to have teachers participate in various forms of authentic scientific inquiry, including phases of experimental design, data collection and analysis, and communication of results. Teachers can use these rich events to make sense of inquiry processes and translate them into their classroom practice. For this study, data was collected from several annual cohorts of teachers participating in two different RET models using the Teacher Belief Interview protocol (Luft & Roehrig, 2007). These data were analyzed to understand categorical changes that occurred in teachers' beliefs from before participation in an RET to following their participation in the program. From the analysis of responses, several interesting trends emerged in the shifts of teacher beliefs. These findings offer support for the beneficial impact of RET programs on teachers' beliefs, which can shape their practice.

Strand 10: Curriculum, Evaluation, and Assessment

S12.9 Related Paper Set - Impact of Educative Materials and Transformative Professional Development on Teachers' PCK, Practice, and Student Achievement

1:00pm – 2:30pm, Bonaire 1

Discussant: April L. Gardner, BSCS

ABSTRACT: Forty teachers participated in an intervention in which they implemented educative materials following transformative professional development. We propose a theory of action, where the intervention initially affects teacher knowledge bases, including PCK, leading to changes in teacher practice and student achievement. The first paper describes the intervention and its impact on teachers' content knowledge, general pedagogical knowledge, and PCK. Teachers showed statistically significant gains in all these areas. The second paper describes a rubric to examine

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teachers' PCK. Factor analysis revealed it includes two factors, content knowledge and pedagogical knowledge. Higher scores on PCK content knowledge, but not PCK pedagogical knowledge, were significantly related to inquiry-based instruction. The third paper examines student achievement, teacher knowledge, and teacher practice using HLM. Only teachers' academic content knowledge accounted for statistically significant amounts of student variance. Teacher practice does not mediate the teacher knowledge bases. The final paper uses interviews to help explain quantitative data. Participants stated they rarely thought about teaching as we define PCK. Teachers stated their greatest gains were inquiry-based teaching, making conceptual connections, and attention to student learning. These gains were not manifest in practice, suggesting that changes to practice occur after changes to teacher knowledge bases.

S12.9.1 Impact of Educative Materials and Transformative Professional Development on Teachers' Pedagogical Content Knowledge

Janet Carlson, BSCS, jcarlson@bscs.org

April L. Gardner, BSCS

S12.9.2 The Measurement of Pedagogical Content Knowledge and Its Relationship to Teacher Practice

April L. Gardner, BSCS

Molly A.M. Stuhlsatz, BSCS

S12.9.3 Using HLM to Examine Relationships Among Teachers' Pedagogical Content Knowledge, Practice, and Student Achievement

Christopher D. Wilson, BSCS

Joseph A. Taylor, BSCS

S12.9.4 Teacher Explanations for Changes in Pedagogical Content Knowledge

Sharon Cardenas, Northern Arizona University

Julie Gess-Newsome, Northern Arizona University

Barbara A. Austin, Northern Arizona University

Strand 11: Cultural, Social, and Gender Issues

S12.10 Symposium - Theoretical and Empirical Analyses of Social Capital and Networking in Science Education: From Global to Local

4:00pm – 5:30pm, Curacao 3

Discussant: Kenneth G. Tobin, The Graduate Center of CUNY, ktobin@gc.cuny.edu

Presenters:

Chan-Jong Kim, Seoul National University

Mariona Espinet, Universitat Autònoma de Barcelona, Catalonia, Spain

Sonya N. Martin, Drexel University

Christina Siry, University of Luxembourg

Konstantinos Alexakos, Brooklyn College, CUNY

Rowhea Elmesky, Washington University

ABSTRACT: The symposium addresses social capital and networks at a variety of social levels including global, regional (international), local (within a city), and classroom. Six presenters and a chair/discussant will participate in an interactive symposium in which each presenter focuses on the topic in which he/she takes the lead. After introducing the topic and exploring important issue is theoretically and empirically there will be interaction among the symposium participants on each of five focus areas. The

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participants are science educators from Korea, Luxembourg, Spain, and the United States. The presenters are diverse in regards to ethnicity and native language. The discussant will provide a synthesis based on the theory and empirical approaches adopted on the projects described by these projects. The six topics to be addressed in the symposium are: ¢ Asian Science Education: Changes and Challenges ¢ European networking in education for sustainable development ¢ English language imperialism in disseminating research globally ¢ Emotions and production of solidarity in a pre-service science methods class ¢ Fictive kinship among students as it mediates the creation of “safe spaces” in a physics classroom ¢ From science class to navigating life: Bridging and bonding forms of social capital as socially transformative forces

Strand 11: Cultural, Social, and Gender Issues

S12.11 Teachers' and Students' Attitudes towards Science and Teaching

1:00pm – 2:30pm, Bonaire 2

Presider: Nievita Bueno Watts, Arizona State University

S12.11.1 Compounding Variables: Positionality of African American Girls as Science Learners

Rose M. Pringle, University of Florida, rpringle@coe.ufl.edu

Thomasenia Adams, University of Florida

Cirecie West-Olatunji, University of Florida

ABSTRACT: While significant progress has been made toward gender equity in science, persistent underachievement still exists among African American girls especially in the middle school years. Embracing positionality as being inextricably linked to power, status and rank privileged by society and one way of defining the dense overlay among the social positions of gender, ethnicity and SES, we sought to explore the positionalities of African American middle school girls in a high poverty school in relation to their interest and achievement as science learners. Our findings from a three year study indicate the girls’ positionality as learners is impacted by interactions among factors such as the perceptions and actions of teachers and counselors along with the nature of science learning experiences being afforded in low-resource schools with high population of marginalized learners. Our findings seek to further the conversation around positionalities of learners as lenses through which we can continue to explore issues around broadening participation in science.

S12.11.2 Building a Scientific Identity in the Figured Worlds of Kindergarten Science

Alicia M. Mcdyre, The Pennsylvania State University University Park, axd252@psu.edu

Deborah C. Smith, The Pennsylvania State University University Park

ABSTRACT: Following recommendations from Taking Science to School (Duschl, Schweingruber et al. 2007), kindergarten teachers and children participated in a community of knowledge builders about seeds and plants. This paper presents findings from the observations made within the classroom and interviews conducted before and after the study. We examined the figured worlds of two girls in this community, focusing on their participation in class discussions about claims and evidence and their individual work within their scientific notebooks. We provide examples of the authoring of their scientific identities within the kindergarten classroom.

S12.11.3 The Effects of Becoming a Science Focus School in Regards to Urban, Low SES, African American Girls' Emotional Engagement with Science

Gayle A. Buck, Indiana University, gabuck@indiana.edu

Kristin L. Cook, Indiana University

Cassie F. Quigley, Clemson University

ABSTRACT: The purpose of this study was to increase the understanding of how to prepare urban teachers to foster an improvement in the science attitudes of urban African American girls from low SES communities. We sought to explore how to improve the science attitudes of girls as a universal whole by exploring the homogeneity and heterogeneity of science attitudes found within a group of 89 African-American girls attending an elementary school that served two

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large urban housing developments as well as the differences in the interventions that foster such improvements. In our mixed methods analysis, we found that the presence of a science focus in the school allowed for an atmosphere in which the majority of students could increase their confidence/non-anxiety and desire/value towards science. Several factors seemed to contribute to these positive gains, such as teacher action research, student participation in a science fair, relevant problem-based teaching approaches, the creation of a science laboratory, and the relationship students developed with their science teacher. By providing a voice of the girls' reflections on how a science academy reform affected them, we gained a glimpse into how professional development collaboration motivates and inspires teachers, which then motivates and inspires their students.

S12.11.4 Discourse of Science: Helping English Language Learners with Speaking, Reading, and Writing

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

Cecilia Silva, Texas Christian University

ABSTRACT: This research extends our prior research focusing on the acquisition of content knowledge and academic language necessary to engage in the Discourse of science. In this phase of the research, we examine ELL language and content as they engage in inquiry-based instruction that moved the students from lessons that had many essential elements that were teacher-driven to more elements that were student-driven. Over a four year period, a total of 180 (95 girls and 95 boys) students attended summer school. During the first two years, all students were Spanish speakers while in the third year nine languages were spoken and in the fourth year twelve languages were spoken. Each year students came with various levels of English language proficiency. Results suggest that 5R instructional model which used reloading language rather than frontloading language during a 3-week unit of instruction did increase the students' canonical knowledge of erosion, academic language about erosion, Discourse of science, and understanding of features of text used in science books. In addition, the students also showed an eagerness in exploring their own questions in science and an increased ability to use evidence to support claims.

Strand 13: History, Philosophy, and Sociology of Science

S12.12 Strategies to teach Nature of Science

1:00pm – 2:30pm, Bonaire 4

Presider: Allan Feldman, University of South Florida

S12.12.1 Impact of a Pure vs. Applied Science Immersion Experiences on Preservice Teachers' View of NOS

Pongprapan Pongsophon, Kasetsart University, Thailand, feduppp@ku.ac.th

William F. McComas, University of Arkansas

ABSTRACT: This study explored the potential impact of two distinct types (pure or applied) of science immersion experiences on pre-service teachers' view of nature of science. Seventeen Thai preservice teachers were assigned to a pure or applied science laboratory for a one hundred hour apprenticeship during year four of a five year teacher preparation program. Multiple data sources were employed to measure impact including; participant observations, review of students' reflective journals, oral presentations and a questionnaire focusing on NOS views. The result indicates that both programs have positive impact on the participants' view on empiricism in scientific inquiry, bias in science, diversity within the scientific community, values in science and the interrelationship between science and society. However, neither type had any impact on participants' knowledge of the nature of scientific knowledge and subjectivity of science. Only the pure science laboratory experience made positive impacts on NOS issues related to the many routes to scientific discovery; creativity in science; and the generation and validation of scientific knowledge within the community of scientists. The paper concludes with a discussion of how learning occurs in apprenticeship environments and how teacher education programs can benefit from such apprenticeship plans.

S12.12.2 Using Mainstream Films to Teach Nature of Science and Scientific Inquiry to Preservice Elementary Teachers

Mark Bloom, Texas Christian University, m.bloom@tcu.edu

Ian C. Binns, Louisiana State University

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Catherine M. Koehler, Illinois Institute of Technology

ABSTRACT: This study involved developing an instrument to analyze how nature of science (NOS) and scientific inquiry (SI) are portrayed in films. We initially chose the film, *Contact*, and, using inductive coding, identified instances of NOS/SI portrayed in the film. Following analysis, we developed a NOS/SI Fingerprint to represent the quality/quantity of such instances. Findings revealed numerous scenes where NOS tenets are authentically portrayed and instances where misconceptions about science are perpetuated. Similar NOS/SI fingerprints were created for three other films: *Twister*, *Jurassic Park*, and *Gorillas in the Mist*. Finally, this fingerprint was basis of instruction in a science course for preservice elementary teachers in which these four films were used to demonstrate NOS/SI. To determine the effectiveness of this teaching strategy, students' understanding of NOS/SI was measured before and after the course using the VNOS D+ and through in-class assignments, journal entries, and a final paper. Findings reveal students were engaged in discussions about NOS/SI and were able to recognize how they were exemplified in the films. In addition, conceptions of several NOS tenets, (creative, and social and cultural) shifted from naïve to informed understandings. It appears that the movies had some influence on this shift.

S12.12.3 The Application of Nature of Science Understandings into Unfamiliar Contexts: Is It Possible?

Rola Khishfe, American University of Beirut, rk19@aub.edu.lb

Mohammed Estaiteyeh

ABSTRACT: The purpose of this study was to investigate whether students would be able to apply nature of science (NOS) understandings acquired in one context (familiar) into an unfamiliar context. Participants were one teacher and his students which comprised two groups of 10th graders. The teacher taught two intact sections of the same grade level about genetic engineering. The treatment spanned 6 weeks and involved teaching a unit about genetic engineering. The unit addressed genetic engineering for one group and genetic engineering that integrates NOS for the other group. The two intact groups learned about the same content of genetic engineering; the only difference was whether NOS was being taught. Two open-ended scenarios, in conjunction with semi-structured interviews, were used to assess the change in participants' views of NOS and their ability to apply their acquired NOS understandings into an unfamiliar context. The questionnaire items addressed familiar and unfamiliar contexts; the familiar context was genetic engineering and the unfamiliar context was water fluoridation. Results showed a general improvement in participants' views of NOS for the treatment group for the familiar and unfamiliar contexts. Implications for classroom teaching are discussed.

S12.12.4 Emergent Understandings of Scientific Creativity in the Secondary Science Classroom Context: Implications for Both Research and Practice

Allison Antink, Illinois Institute of Technology, aantink@iit.edu

ABSTRACT: Although consensus exists among educators that facilitating student creativity in the science classroom is desirable, Baer (1993) points out that classrooms generally do not adequately identify or develop creativity among students. Thus a dilemma is clear; while the desire for students to develop the skills and tendencies characteristic of scientific creativity exists, the ability of science classrooms to foster such development is questionable. A robust characterization of the ability of science classrooms to foster the expression of scientific creativity is badly needed if, as an educational community, we intend to move forward. The rationale of the present study, therefore, is grounded in the development of a characterization of science teachers' and classrooms' conceptions of and support for scientific creativity.

Strand 1: Science Learning, Understanding and Conceptual Change

S13.1 Related Paper Set - Moving Language in Science Research Forward: Interpretative Frameworks, Research Procedures, and Pedagogical Issues to Reposition Literacy in Scientific Literacy

2:45pm – 4:15pm, Curacao 1

President: Larry D. Yore, University of Victoria

Discussant: Zhihui Fang, University of Florida

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ABSTRACT: These papers address theoretical, procedural, and practical issues dealing with the cognitive symbiosis within the 'scientific literacy for all' problem space: Multiple representations and linguistic diversity. The researchers are focused on the changes regarding learning from text to learning with text, the 3-language (home, school, and science languages) problem, and the differential functions of language (constructive, interpretative, and persuasive roles) in learning science. Their studies have surfaced new theoretical frameworks that consider learner-generated multiple representations; procedures to detect and interpret attached, embedded, and cohesive multimodal representations; practices of strategic code switching during classroom instruction; and functionality of language and literacy tasks during science inquiry involving English language learners. Study 1 reports a systematic review and metasynthesis leading to a theoretical framework for multimodal text. Study 2 reports on how connections between verbal text and other modes of representation in writing-to-learn products impact learning. Study 3 reports on the use of code switching in elementary school science instruction in South Africa. Study 4 reports on PD programs that modified the traditional 5E inquiry learning cycle format to incorporate explicit language development strategies for teachers to utilize with their English language learners.

S13.1.1 Going Beyond 'Science Literacy for All' as a Slogan to a Cognitive Model: Introduction

Larry D. Yore, University of Victoria

S13.1.2 Changing from Users to Producers of Multimodal Texts: A Theoretical Framework Based on Cognition, Metacognition, Semiotics, and Systemic Functional Linguistics

Christine D. Tippet, University of Victoria

Robert J. Anthony, University of Victoria

S13.1.3 Attachment, Embeddedness, and Integration: Levels of Cohesiveness in Multimodal Writing Tasks and Impact on Student Learning in Science

Mark McDermott, Wartburg College

Brian Hand, University of Iowa

S13.1.4 The Theoretical Basis and the Cognitive, Linguistic and Pedagogical Advantages of Code Switching in Multilingual Classrooms of South Africa to Address the 3-Language Problem (home, school and science)

Mary Grace Villanueva, University of Iowa

Paul Webb, Nelson Mandela Metropolitan University

S13.1.5 Functional Linguistics, Language Tasks and Strategies, and Science Inquiry Using the 5E Approach

Susan Gomez-Zwiep, California State University, Long Beach

William Straits, California State University, Long Beach

Lauren Shea, University of California, Irvine

Therese Shanahan, University of California, Irvine

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S13.2 Science Learning in Authentic Contexts: The Impact of Place and Voice on Rural Students' Experiences

2:45pm – 4:15pm, Curacao 2

Discussant: Angela M. Calabrese-Barton, Michigan State University

Presenter: April L. Luehmann, University of Rochester

ABSTRACT: Rural students are arguably the most overlooked group of students who have been historically marginalized from the discourses of science and school science. This paper set addresses both the international and equity aspects of the NARST theme by exploring the methods and resulting impact of four ways instructors tapped into rural students' funds of knowledge and sense of place to engage them more fully in their school-based science learning (either secondary or college level). Findings from these studies indicate that students are often unaware of the value of their

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funds of knowledge for learning science; that rural students often have many, often consistent and largely untapped funds of science-related knowledge that are tightly connected to their sense of place (e.g. local mammals); that giving students opportunities to both develop and tell their stories in scaffolded ways (including their place-based situatedness) supports science learning and identity development; and that learning science by doing science in meaningful places (e.g., wildlife tracking, investigating water quality of local lakes; ecological studies of local ponds; and conducting studies on leaf-cutter ants in a Central American rainforest) leads to positive and productive science learning and, perhaps more importantly, positive (potentially transformative) identity work (science and otherwise).

S13.2.1 Eliciting, Identifying and Utilizing Rural High School Students' Funds of Knowledge in the Service of Science Learning in their Backyard

Ellen M. Lloyd, University of Rochester, ellenmlloyd@hotmail.com

S13.2.2 Eliciting and Activating Funds of Knowledge in an Environmental Science Community College Classroom

John VanNiel, University of Rochester

S13.2.3 Using Place-Based Pedagogy in a High-Stakes Biology High School Course

Peter Saracino, University of Rochester

S13.2.4 The Use of Exotic Spaces and Experiences to Inspire and Inform Rural Students' Construction of Personal Science Stories

Joseph A. Henderson, University of Rochester

April L. Luehmann, University of Rochester

Brian Bailey, Nazareth College

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

S13.3 Symposium - What Works When and How: Investigating Capacity Building in a Large Scale STEM Education Reform Program

2:45pm – 4:15pm, Curacao 4

Presenters:

Susan Yoon, University of Pennsylvania, yoonsa@gse.upenn.edu

Lei Liu, University of Pennsylvania

Jorge Santiago-Aviles, University of Pennsylvania

Sao-Ee Goh, University of Pennsylvania

Dorothea Lasky, University of Pennsylvania

Betty Chandy, University of Pennsylvania

Joyce Wang, University of Pennsylvania

Kira Baker-Doyle, Pennsylvania State University

ABSTRACT: The series of studies in this related paper set aim to address the need for reforming STEM education toward 21st century goals. They collectively focus on providing empirical evidence in real world classroom contexts of the impact of professional development and curricular and instructional programming on capacity building in multiple educational arenas. The studies have been generated from a single NSF-funded project under the program title Innovative Technology Experiences for Students and Teachers. The project aims to upgrade the high school science curriculum in various subject domains to reflect STEM research and development activities happening in the field of nanotechnology. The six studies in this series emphasize using frameworks or lenses that may represent theories of action to answer the question what works when and how. The research questions and methodologies address multiple components of the educational system including: i) program evaluation; ii) content knowledge; iii) teacher practices; iv) teacher dispositions and beliefs; and v) collaborative learning. Through this bricolage approach that encompasses

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essential STEM education reform elements, we aim for participants to develop a rich understanding of the possible frameworks for increasing capacities through which successful programming can be measured.

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

S13.4 Scientific Literacy & Societal Issues in Science Instruction

2:45pm – 4:15pm, Curacao 5

Presider: Geoffrey Potvin

S13.4.1 Exploring Genetic Literacy: How Undergraduate Science Majors Reason About Authentic Genetic Dilemma

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

Ravit Duncan, Rutgers University

Celeste Stephenson, Rutgers University

ABSTRACT: Genetic literacy is becoming increasingly important as advancements in our application of genetic technologies such as stem cell research, cloning, and genetic screening become more prevalent. Research has shown, however, that many high school graduates lack the genetic knowledge necessary to participate in public debates over emerging genetic technologies. Very few studies examine the relationship between argument construction and genetic content knowledge when reasoning about authentic genetic dilemma students may face as citizens. We present our findings from a comparative interview study between novice (freshman/sophomore) undergraduate students majoring in biological sciences and advanced (junior/senior) undergraduate students majoring in genetics. We conducted a semi-structured interview with each student which was composed of two authentic reasoning tasks in plant and human genetics. We assessed student dialogue for genetic content knowledge and quality of argument construction. Overall we found that advanced students were more likely to apply their content knowledge of genetics, within group differences arose in terms of reasoning ability within each context, and reasoning about the underlying mechanisms of genetic phenomena was difficult for both groups within each context. This work provides insights as to the conceptual obstacles and leverages involved in complex reasoning in the domain of genetics.

S13.4.2 Conceptually Eleven?: The Disconnect between Expectations and Undergraduate Conceptual Understanding in Earth and Related Sciences

Julie Libarkin, Michigan State University, libarkin@msu.edu

Anila Asghar, McGill University

ABSTRACT: The purpose of this study was to understand the relationship between community (both scientists and science educators) expectations for scientific literacy and the state of scientific literacy in college classrooms about fundamental phenomena considered essential for both public scientific literacy and pre-teens. In particular, we sought to link K-12 standards with public literacy standards in the Earth and related sciences, and to further link these with studies of college student conceptual understanding. This work proceeded through two meta-analyses. First, we identified significant themes that cut across in the AAAS 5th grade Benchmarks for Scientific Literacy and the Essential Principles for Atmospheric Science, Climate Science, Earth Science, and Ocean Science. Second, we conducted a meta-analysis of literature on college student conceptions to look for documented alternative conceptions that aligned with the themes identified in the Benchmarks and Essential Principles. Our review indicates that benchmarks for science that students are expected to have acquired by grade 5 are commonly misunderstood by college students. Many college students carry alternative conceptions about the foundational Earth Science concepts. The study generates important implications for college science pedagogy in terms of addressing students' alternative conceptions and building an advanced understanding of complex concepts in Earth sciences.

S13.4.3 Measuring the Use of Science Content During Socioscientific Issues Negotiation: The SSI-Q

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

Dana L. Zeidler, University of South Florida

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ABSTRACT: The Socioscientific Issues Questionnaire (SSI-Q) was initially developed as part of a larger study which explored the science content used during college students' negotiation of three biology-based socioscientific issues (SSI) and examined how it related to students' conceptual understanding and acceptance of biological evolution. In order to broaden the scope of content measured, it was further developed by adding additional scenarios designed to utilize a variety of science content. This presentation reports students' SSI-Q scores for each scenario and applications of the rubric for different SSI scenarios. Results indicate that many participants inaccurately use science content during SSI negotiation and/or do not use it to the fullest extent possible. Implications for research and teaching are discussed.

S13.4.4 Participation in an Interdisciplinary, Socioscientific Issues-Based Human Biology Major and Understanding of Scientific Inquiry

Jennifer L. Eastwood, University of Florida, jleastwood@coe.ufl.edu

ABSTRACT: Recently a need has been expressed for college education geared to prepare graduates to understand complex issues that require critical examination of different disciplinary perspectives such as climate change, resource management, and disease epidemics. The pedagogical framework of socioscientific issues (SSI), which integrates science concepts and their social significance through discussion and debate, is consistent with such calls. Considering that effective reasoning with SSI involves making evidence-based arguments, it is important to consider students' understanding of the inquiry process from which evidence is derived. This study investigates a four-year interdisciplinary, socioscientific issues-based undergraduate human biology major focused on the progressive development of evidence-based reasoning. This study investigates whether students participating in this major (SSI) view scientific inquiry differently from those who experience a traditional biology major (BIO). SSI students were more likely to include social science inquiry in their definition of inquiry and see inquiry as problem-centered and stemming from questions. Both groups held misconceptions or gave vague definitions of evidence, despite efforts of SSI professors to explicitly address it in class. Findings have important implications for science fields where complex problems require interdisciplinary understanding, and suggest future research on helping students understand the meaning of evidence.

S13.4.5 Scientific Literacy of Undergraduate Students Enrolled in Science Faculties

Bulent Cavas, Dokuz Eylul University, Izmir, Turkey, bulentcavas@gmail.com

Yasemin Ozdem, Gaziosmanpasa University, Tokat, Turkey

Pinar H. Cavas, Ege University, Izmir, Turkey

Jale Cakiroglu, Middle East Technical University, Ankara, Turkey

Hamide Ertepinar, Middle East Technical University, Ankara, Turkey

ABSTRACT: In many countries, science education reforms were constructed on scientific literacy (SL) which is required by the future generation of societies. This raises the question of how the students can be educated better in order to achieve goals identified in the national curriculum. The purpose of this study was to investigate science department students' SL level in overall and in the sub dimensions. The Turkish version of Test of Basic Scientific Literacy (TBSL) and the Scientific Attitude Inventory (SAI-II) were used to collect data from students (NPhysics=171, NChemistry=206, NBiology=203) enrolled in Art and Science Faculty. The selected domains of SL in this study were scientific concept knowledge or science content (SCK), nature of science (NOS), and effect of the nature of technology including technology and society, design and systems, and issues in technology (NOT). The statistical analysis revealed that 25.6% of Physics, 38.8% of Chemistry and 34.5% of biology students were considered as scientifically literate students. It is suggested that more importance should be given to science faculties to educate better scientists who have knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity.

Strand 7: Pre-service Science Teacher Education

S13.5 Symposium - Engaging Pre-service Teachers in Multiple Modal Learning as Animation Creators: International Perspectives on Using Slowmation

2:45pm – 4:15pm, Bonaire 7

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Presider: Allan Feldman, University of Southern Florida, USA

Discussant: Brian Gravel, Tufts University, USA

Presenters:

Garry F. Hoban, University of Wollongong, Australia, ghoban@uow.edu.au

Wendy Nielsen, University of Wollongong, Australia

Gillian Kidman, Queensland University of Technology, Australia

Pernilla K. Nilsson, Halmstad University, Sweden

Stephen Keast, Monash University, Australia

Rebecca Cooper, Monash University, Australia

Calee Bullard, Monash University, Australia

Denis Jablonski, Southern Oregon University, USA

ABSTRACT: This symposium draws together five science teacher educators from three different countries who have explored the use of a new teaching approach that encourages pre-service teachers to design and make animations to explain science concepts. The type of animation exemplified is called a “Slowmation” (abbreviated from “Slow Animation”), which is a simplified way for pre-service teachers to design and make a narrated stop-motion animation to explain a science concept. The theory underpinning slowmation derives from social semiotics resulting in preservice teachers designing and making a sequence of five multimodal representations, each with affordances to help pre-service teachers think about a science concept in particular ways: (i) Representation 1—Research; (ii) Representation 2—Storyboard; (iii) Representation 3—Models; (iv) Representation 4—Photographs; and (v) Representation 5— the Animation. The symposium will provide examples of the use of slowmation from five different science teacher education courses, three for elementary and two for secondary preservice teachers. The symposium will explain, discuss and critique the five studies to show the diverse ways in which slowmation can be used in pre-service science education classes. Slowmation is a new teaching approach that engages pre-service teachers in designing and making multimodal representations to explain science concepts.

Strand 8: In-service Science Teacher Education

S13.6 Teacher Beliefs and Self-efficacy

2:45pm – 4:15pm, Curacao 8

Presider: Lawrence Flick, Oregon State University

S13.6.1 Effect of the SUN Project Workshop on Teacher Self-Efficacy

Ann Batiza, Milwaukee School of Engineering, batiza@msoe.edu

Mary Gruhl, Gruhl Education Consultants LLC

Eric Hagedorn, University of Texas, El Paso

Bo Zhang, University of Wisconsin - Milwaukee

Tim Herman, Milwaukee School of Engineering

Dave Nelson, University of Wisconsin-Madison

ABSTRACT: Previously we reported significant improvement in teacher comprehension of biological energy transfer and confidence in their knowledge of items on the knowledge assessment as a result of the SUN (Students Understanding eNergy) Project Workshop [Reference masked for review]. Here we report on the effect of the workshop on teacher overall teacher self-efficacy. Attendance at the SUN workshop significantly improved the self-efficacy of the treatment teachers, as measured by a version of the STEBI-A (Riggs and Enochs, 1990) we modified to assess self-efficacy with regard to biological energy transfer concepts. The Treatment Group Teachers were also significantly improved relative to the PRE scores of the randomly assigned controls and were no longer significantly different from the AP Pilot group. Analysis of the “Belief” and “Student Expectancy” subscales indicated that teachers significantly improved their belief in their ability to teach these topics as a result of the SUN Workshop, but they did not significantly improve their expectancy that students would learn.

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S13.6.2 The Achilles' Heel of Science Inquiry in Elementary Classrooms: Teachers' Beliefs and Dilemmas

Mijung Kim, National Institute of Education, mijung.kim@nie.edu.sg

Aik-Ling Tan, National Institute of Education

Frederick Talaue, National Institute of Education

ABSTRACT: A new primary science syllabus with strong inquiry focus has been implemented since 2008 in Singapore. In this study, we attempted to understand how teachers experience the emphasis of an inquiry-based curriculum under the current educational conditions that is routinized and highly teacher-fronted. We invited 50 pre-service and 41 in-service teachers to participate in survey questionnaires, reflective writings, and group discussions which eventually formed our data corpus. Data analysis in the form of thematic coding was carried out using NVivo8, with 80% coding agreement level. For science inquiry, the teacher- participants award value and critical significance to three key factors in their practice: (1) their responsibility as facilitator, (2) current and sound content knowledge rather than process skills, and (3) pressure of assessment systems in current educational contexts. Based on these teachers' perceptions and dilemmas of inquiry science teaching, teachers' strategies of inquiry teaching in science classrooms will be discussed.

S13.6.3 A National Study of Elementary Teachers Science Inquiry Professional Development, Knowledge, and Instructional Practice

Gwen C. Nugent, University of Nebraska-Lincoln, gnugent@unl.edu

Jon E. Pedersen, University of Nebraska-Lincoln

Sue Ellen Dechenne, University of Nebraska-Lincoln

Fran Chumney, University of Nebraska-Lincoln

Greg Welch, University of Nebraska-Lincoln

ABSTRACT: Despite the emphasis on the development of inquiry skills in the science standards and reform movements, the research base on how to effectively teach inquiry remains limited. The problem is particularly acute among elementary teachers, who are expected to teach multiple subjects and often have limited science knowledge, science pedagogical content knowledge, and low science teaching self-efficacy. Additional challenges arise when considering the rural teaching context. The purpose of this national elementary teacher professional development study is to investigate: a) elementary teachers' participation in inquiry professional development, b) the characteristics of such professional development and c) teacher perceptions and classroom practices pertaining to the training foci. Comparisons are made to professional development practices in reading and mathematics and between rural and non-rural teachers. Preliminary results show that elementary teachers spend less instructional time on science than on reading and math and that a smaller percentage participate in science professional development. Science professional development is more likely to be led by external trainers/consultants than local teachers and is less likely to include coaching. Results provide insight into topics that are most often included in inquiry professional development and classroom practice and that are perceived as important to student learning.

S13.6.4 Elementary Teachers' Beliefs about Lesson Sequencing

Barbara Austin, Northern Arizona University, baa49@nau.edu

Nena Bloom, Northern Arizona University

Sandie Grinnell, Mount Elden Middle School

Jane Kirkley, Northern Arizona University

ABSTRACT: One of the most efficient ways for teachers accustomed to traditional teaching to improve their practice is through changing the sequence in which they teach. By inverting laboratory activities and teacher lecture so that the laboratory activity precedes the teacher lecture, the laboratory transforms from a verification lab into an exploration through which students can construct their knowledge about the observed phenomenon. In this project, we examined elementary teacher thinking about lesson sequencing from 109 teachers participating in four different professional development institutes focused on science content instruction. While teachers were able to choose reasonably effective sequences for lesson instruction, they were not able to articulate a coherent or research-based framework for their chosen sequences.

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Strand 8: In-service Science Teacher Education

S13.7 Nature of Science

2:45pm – 4:15pm, Bonaire 8

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

S13.7.1 Understanding Science: Improving instruction on the nature and process of science

Anastasia Thanukos, University of California Museum of Paleontology, thanukos@berkeley.edu

Molly A.M. Stuhlsatz, BSCS

Judy Scotchmoor, University of California Museum of Paleontology

ABSTRACT: Understanding Science (www.understandingscience.org) is a comprehensive educational resource that provides a friendly primer on the true nature and process of science (not the watered down version found in textbooks), along with case studies, science stories, and K-16 educational resources that support the teaching of these concepts. An in-service training program was designed to help teachers understand these concepts, use Understanding Science materials in their classrooms, and more broadly re-orient their science teaching to make explicit and reinforce the nature and process of science within the disciplinary content they teach. We undertook a formal evaluation of this in-service program. Findings indicate a high level of teacher buy-in, meaningful increases in student understanding of the nature and process of science, and many teacher reports of increases in student engagement, motivation and understanding. Perhaps most intriguingly, using multilevel modeling to predict end-of-year student achievement on the nature-and-process-of-science assessment revealed that teacher implementation level of Understanding Science materials positively impacted student score after pretest score was accounted for. This indicates that teachers who continued to implement the materials after the initial phase of the project impacted student learning to a greater degree than those teachers who implemented the minimum required material.

S13.7.2 New Directions: A New Set of Analyses of How Beginning Teachers Change Their Understanding of NOS

Jonah B. Firestone, Mary Lou Fulton Teachers College, Arizona State University, jonah.firestone@gmail.com

Charles Weeks, Arizona State University

Sissy S. Wong, University of Houston

Krista L. Adams, Arizona State University

Irasema B. Ortega, Arizona State University

Julie A. Luft, Arizona State University

ABSTRACT: Feiman-Nemser (2001) emphasizes the induction period as the most important part of a teacher's career, but very little study of this period has occurred. This lack of research into what occurs during a teacher's first two years in the classroom leaves the discussion of how a teacher develops, how to train teachers, and why teachers leave incomplete. Previous studies have focused on individual teachers or small groups. This has led to a gap in our knowledge as to how teachers develop over time in terms of their beginning beliefs about how to teach science, their initial development of PCK, and changes in their understanding of NOS. In order to address this an NSF funded study was designed to follow 114 secondary science teachers from the beginning of their first year of teaching through their fifth year in the classroom. Because of the nature of the study in terms of the number of teachers and the length of time that these teachers were followed, various challenges had to be overcome. To address these challenges instruments used to assess concepts such as a teacher's beliefs as to how to teach science and their understanding of the NOS had to be modified.

S13.7.3 Lasting Impact: Teachers' Report of How Professional Development in Modeling Has Influenced Their Teaching

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

Cynthia Passmore, School of Education, University of California, Davis

ABSTRACT: Teachers engaged in professional development on model-based inquiry are bound to be caught up in the ideas and strategies presented. But what happens a year after the program ends and teachers are no longer supported by a community of researchers, scientists and peers? This study asked secondary science teachers what remained salient to them a year after completing a two-year professional development program on model-based reasoning (MBR), and its

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continuing impact on their classroom teaching. The study analyzed written reflections and transcripts of interviews occurring in the year following teachers' completion of the program and identified three ways that teachers claim to have enacted their learning: 1) using modeling activities to illustrate the nature of science without substantially integrating models into the way students learn science, 2) adopting pedagogical strategies that support student interaction (as might be used in modeling contexts) without actually allowing students to grapple with models as part of their learning; and 3) integrating modeling into at least a portion of their content instruction in substantive ways. The variation helps us understand the steps or stages in teachers' adoption of modeling practices and the ways teachers might blend modeling principles with prior understandings about teaching and learning.

S13.7.4 Inquiry-based Instruction in Science Classrooms: Is it Happening?

Daniel K. Capps, Cornell University, dkc39@cornell.edu

Barbara A. Crawford, Cornell University

ABSTRACT: This study examined the teaching practice as well as views of inquiry and nature of science of a group of highly qualified 5th-9th grade teachers prior to their participation their engagement in a National Science Foundation funded inquiry-based professional development program. We used a range of data sources including program applications, classroom observations and videotape data, an open-response views-survey, and semi-structured interviews to assess teachers' views and practices prior to participation in the program, and to look for relationships between teachers' views and their teaching practice. Findings indicated that most teachers held fairly naïve views on inquiry-based instruction and NOS. In general, these views were reflected in their teaching practice. The majority of these teachers used primarily teacher-centered instructional practices. Aspects of inquiry including abilities, understandings, and essential features were observed in less than half of the classes. Most commonly, teachers focused on abilities to do inquiry instead of the essential features of or important understandings about inquiry. This study documents that even highly qualified teachers struggle to enact reformed-based teaching and highlights the critical need for rigorous professional development to support teachers in learning about inquiry and NOS and enacting reform-based instruction in their classrooms.

Strand 10: Curriculum, Evaluation, and Assessment

S13.8 Related Paper Set - Learning Engineering, Engineering to Learn

2:45pm – 4:15pm, Bonaire 1

Presider: Senay Purzer, Purdue University, School of Engineering Education

ABSTRACT: This paper set brings together five studies that focus on engineering education in grades 3 through 8 and address diverse aspects of K-12 education ranging from standards and curriculum evaluation to student learning. The first paper examines how state standards and the newly proposed National Science Education standards address engineering concepts and skills and provides an overview of the paper set. The second paper examines an engineering curriculum that uses LEGO and engineering design to promote third and fourth grade students' learning and interest in science. The third paper takes us into the classroom and presents how middle school students use science and mathematics as they designed cardboard chairs. The forth paper discusses the evaluation of a widely-used K-6 engineering curriculum, Engineering is Elementary, and presents data from more than 2,000 students. Finally, the fifth paper shows how an eight-grade teacher differentiates her instruction between high-achieving and low-achieving students when teaching engineering. Although design emerges as a common thread in all papers, these studies also reflect diverse motivations for teaching engineering in K-12 classrooms: to promote science learning, to increase students' interest in science and engineering, and to enhance students' knowledge about engineering.

S13.8.1 Engineering in the National and State Standards

Senay Purzer, Purdue University

Johannes Strobel, Purdue University

Heidi Diefes-Dux, Purdue University

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S13.8.2 Not Your Typical Chair-ity Case: STEM Integration as a Means for Engineering Design

Tamara J. Moore, University of Minnesota
Gillian H. Roehrig, University of Minnesota
Hui-Hui Wang, University of Minnesota
Mi Sun Park, University of Minnesota

S13.8.3 Engineering-design-based Science, Science Content Learning, and Science Attitudes in the Elementary Grades

Kristen Bethke Wendell, Tufts University
Amber Kendall, Tufts University
Merredith Portsmore, Tufts University
Christopher Wright, Tufts University
Linda Jarvin, Tufts University
Chris Rogers, Tufts University

S13.8.4 Parachutes and Solar Ovens: An Evaluation of Engineering Units for Elementary School

Cathy Lachapelle, Museum of Science, Boston
Christine Cunningham, Museum of Science, Boston

S13.8.5 Who Should Learn Engineering? A Case Study of One Teacher's Disparate Teaching Approach with Lower-achieving Students

Christine G. Schnittka, University of Kentucky

Strand 11: Cultural, Social, and Gender Issues

S13.9 Symposium - Ecosystems of Science Across Borders

2:45pm – 4:15pm, Bonaire 2

Presenters:

Sumi Hagiwara, Montclair State University, hagiwaras@mail.montclair.edu
Janell N. Catlin, Teachers College, Columbia University
Tara O'Neill, University of Hawaii - Manoa
Felicia Moore-Mensah, Columbia University
Meghan E. Marrero, U.S. Satellite Laboratory
Jessica F. Riccio, Columbia University
Jonathan Gerlach, Hillsborough County Public Schools
Bhaskar Upadhyay, University of Minneapolis
Kristina Maruyama-Tank, University of Minneapolis
Nancy Albrecht, University of Minneapolis

ABSTRACT: The proposed symposium examines collaborations between members of the school and community ecosystems to conserve science in policy and practice, and enable learners to be actively engaged in the global scientific community. This symposium will present five initiatives that aim to ensure sustainable school practices to enhance and support science teaching and learning through collaborative efforts across geographic and socially constructed borders. The presenters will: 1) examine the professional development practices of middle school teachers in collaboration with educators in China and Panama; 2) support science teacher preparation and improve student competencies in science, technology, engineering and math (STEM) by examining sustainability issues through university partnerships with the National Air and Space Administration (NASA); 3) enhance preservice teacher preparation through distance learning and technologies in Oahu and New York City; 4) examine the discursive practices of racially and ethnically diverse students in Minneapolis as they bridge scientific understandings with culturally engrained practices; and 5) model a New York City based university-school partnership that includes ten urban neighborhood K-12 schools to provide teacher professional

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development, in-classroom support and after school programming for students in a push towards preparing students to participate in a global society.