

Fouad Abd-El-Khalick

Professional growth through engagement: Overcoming bureaucratic and personal barriers associated with top-down models of professional development. *P*-784-1693-1690-1720

This seminar will examine professional development of science educators from a variety of perspectives. BouJaoude and Dillon will present the preliminary results of a survey of the readership of science education journals worldwide that aimed to determine the extent to which science educators learn from the experiences of international colleagues. Fraser-Abder will present a global perspective on professional development activities that provide a forum through which teachers can hone their skills, develop, support, and begin to address the specifications of working with their schools . Dillon s contribution will focus on the variation across Europe in terms of science professional development while Hofstein and Mamlok-Naaman will discuss three models of professional development used with Israeli science teachers. Finally, Abd-El-Khalick will focus on professional development for Egyptian teachers by describing two realizations of the Professional growth through engagement model used in large and small scale educational reform projects in Egypt.

Sandra Abell Patrick Brown Patricia Friedrichsen Deanna Lankford Enrique Pareja Mark Volkmann

The PCK of Future Science Teachers in an Alternative Certification Program P-151-242-241-278

Alternative certification programs are designed to recruit individuals with strong content knowledge and career experiences into the teaching profession and prepare them to teach in a reduced amount of time. Science education researchers know little about the entering knowledge for teaching that such individuals possess. In this study, we used the lesson planning method to document the incoming PCK of future science teachers enrolled in one alternative certification program. We constructed profiles of 13 individuals and generated a set of assertions from a cross-case analysis of these profiles. Several patterns in the lesson plans emerged from the data analysis: (a) the focus of instruction and assessment on student understanding of vocabulary; (b) the use of single forms of teacher-directed instructional strategies and single representations of phenomena; and (c) the development of learning goals that were more appropriate for college than middle level students. Participants PCK was influenced by their own level of content knowledge and their experiences with science teaching. Our actions to facilitate the development of PCK must take such views into account if we are to be successful at preparing highly qualified science teachers.

Issam Abi-El-Mona Fouad Abd-El-Khalick

Perceptions of Argumentative Discourse among Freshmen College Students, Science Teachers, and Practicing Scientists P-404-711-710-745

The study aimed to (a) elucidate college Freshmen science students, secondary science teachers, and practicing scientists' perceptions of scientific arguments and how these perceptions compare to Toulmin's (1958) formal analytical frameworks, which is often used to analyze arguments in the science education literature, and (b) characterize the nature of the criteria that participant students, teachers, and scientists deploy when assessing the 'validity' of arguments. Participants were 30 (50% female) students, science teachers, and scientists with 10 participants in each group. In-depth, semi-structured interviews served as the main instrument of data collection. In two separate interviews, participants first constructed arguments in defense of a certain standpoint in the context of global warming, and then assessed and provided feedback on the arguments generated during the first interview by three other participants: One generated by a member of their peer group and arguments generated by one member of each of the other two groups. Data analyses indicated that all participants, including scientists, did not fare well when strictly judged from the perspective of Toulmin's structural elements of argument. The findings point to a mismatch between empirically-derived conceptions of argument based in scientific practice and those derived from formal analytical frameworks often used by science educators.

NARST Annual International Conference 2007

Emine Adadan Karen Irving Kathy Trundle

High School Students' Learning Pathways of the Particulate Nature of Matter P-409-721-720-755

This longitudinal study of 42 high school chemistry students' learning pathways of the particulate nature of matter (PNM) from the pretest to post and to the delayed posttest uses a quasi-experimental design. Two groups of students followed either one of the instructional interventions of the Reform-Based Teaching with Multiple Representations (RBTw/MR) or the Reform-Based Teaching (RBT). Qualitative research methods, including open-ended questionnaires and interviews, were used to investigate and describe students' conceptual understandings of the PNM over time. Each group of students was tested on their understanding of the aspects of the PNM by open-ended questionnaires before instruction, immediately after instruction and three-months after instruction. Selected students from each group were interviewed after the post-questionnaire. Data analysis revealed nine different learning pathways in the RBTw/MR group ranging from radical progress to no progress and stable to full decay. However, only 3 of these 9 learning pathways stood out as the typical patterns in the RBT group, which varied from slight progress to no progress and stable to full decay. These patterns showed that students in the RBTw/MR group developed more scientific understandings than the students in the RBT group, and those scientific understandings persisted over time.

April AdamsMonica MacklinRenee CambianoJames OliverSkyleen WillinghamVicky HurstMelissa UnderwoodImage: Cambiano of the Analysis of Inquiry Rubric Based on Observations of Practicing Teachers and ItsThe Development of the Analysis of Inquiry Rubric Based on Observations of Practicing Teachers and ItsImage: Cambiano of Practicing Teachers and ItsP-172-918-917-951Practicing TeachersPracticing Teachers

In this study, video-taped science inquiry lessons from 10 first through ninth-grade teachers were used to develop the Analysis of Inquiry Rubric (AIR). This rubric which is based on the Essential Features of Inquiry and Its Variations (NRC, 2000) documents the behaviors and skills shown by teachers while they are engaged in effective inquiry-based instruction as affirmed by the Reformed Teaching and Observation Protocol. The AIR will be presented and its development and implications for elementary and middle school science teacher preparation will be discussed. The AIR provides practical insight into the behaviors and skills that need to be developed in pre-service elementary and middle school science teachers.

Paul AdamsZdeslav HrepicGermaine TaggartLanee YoungDeveloping an Inquiry-Based Physical Science Course for Preservice Elementary TeachersP-660-1389-1388-1420

Preservice elementary teachers should experience science through inquiry in order to be effective in teaching science. In addition, inquiry as a mode of teaching is mandated by xxxx and the National Science Education Standards. As a result of the No Child Left Behind Act, teachers also need to be prepared to include basic skills in reading and mathematics in all instruction. To address these issues, xxxx adapted and extended the NSF-developed teacher enhancement materials Operation Primary Physical Science (OPPS) for use in a physical science course for preservice elementary teachers. This paper presents the main features of OPPS, describes advantages of using it as a template in developing desired course material and discusses results collected with students enrolled in the adapted course during 2004/2005 academic year in terms of the effectiveness of the adaptation.

Brian Adrian Dean Zollman Scott Stevens

What questions do teachers ask when seeking help with their teaching? P-454-1472-1471-1502

An online help system for teachers of physics is being used to explore the kinds of questions teachers ask when seeking help with their physics teaching. The Physics Teaching Web Advisory (Pathway) makes use of an interface that is similar to conversing with a real person; thus, user questions are in a conversational format and can be easily categorized. This study has analyzed these questions and found that very few of the questions asked about either activities or assessment. Given that current Physics Education Research encourages active learning, it is surprising that so few teachers have questions in these areas. We suggest several possible reasons for this confounding problem.

Sheraton New Orleans Hotel • New Orleans, LA

Behiye Bezir Akcay Hakan Akcay

Explicit/Reflective Approach to Enhance Pre-Service Science Teachers Understanding of the Nature of Science Concepts P-500-1248-1247-1279

This study assessed the influence explicit/reflective instructional method on pre-service science teachers understanding of nature of science concepts, and examined whether participants who entered the HOS course with a conceptual framework consistent with current NOS views achieved more elaborate NOS understanding. Participants were 22 undergraduates and graduate students enrolled in HOS course in a midsized university on the Midwest. An open-ended questionnaire was used to assess participants pre- and post- instruction NOS views. Individual interviews were used to establish the questionnaire s validity. Eighteen percent of the participants were randomly selected for the interviews at the end of the study. Other data sources included field notes, students lesson plans and reflective papers. The results of this study show that explicitly addressing certain aspects of the NOS is effective in promoting adequate understanding of the NOS for pre-service science teachers.

Hakan Akcay Robert Yager Behiye Bezir Akcay

The effect of STS course as Preparation for Science Teaching P-541-1428-1427-1459

The purpose of this study is to determine the impact of an STS/Constructivist learning environment on the belief of preservice science teachers concerning constructivism and science teaching and learning as a result of their experiences in an STS based course that was a part of their preparation program. The Constructivist Learning Environment Survey (CLES) and the Philosophy of Teaching and Learning (PTL) provided data from 41 preservice science teachers to evaluate the impact of perceptions of the students concerning STS/ constructivism and beliefs about science teaching and learning. The results of this study indicated that there are positive changes made in terms of perceptions of TS/constructivism. These significant changes were not affected by gender and grade (elementary vs secondary) level of the student.

Valarie Akerson Cary Buzzelli

The Relationship of Cultural Values, Intellectual Levels and Preservice Teachers Views of Nature of Science P-18-96-95-132

This study explored relationships between preservice early childhood teachers views of nature of science (NOS) (Lederman, 1992), intellectual developmental levels (Perry, 1999), and their cultural values (Schwartz, 1992), after participating in a science methods course that emphasized explicit reflective NOS instruction, and a foundations course that emphasized cultural values. We found that though preservice teachers at all Perry Positions improved their views of NOS, there were patterns of views by position; those at the position of dualism described their views in terms of one right truth, while those at the multiplicity position described their views in terms of viewing evidence from many different interpretations. Students' NOS views are also related to their cultural values. Implications for teacher preparation will be made.

Valarie AkersonDeborah HansonTheresa Cullen

Supporting Elementary Teachers Efforts to Teach Nature of Science through Action Research Q-18-89-88-125

This study assessed the influence of a two year professional development program during which elementary teachers used teacher-designed action research studies to track the effectiveness of their instruction on elementary students views of NOS. During the first year of the

program teachers improved their conceptions of NOS, and learned teaching strategies for teaching about NOS to their students. During the second year of the program teachers learned how to conduct action research and carried out their own designed studies to explore the influence of their instruction on their students NOS views. Teachers' NOS and inquiry views were assessed using the VNOS-D2 and VOSI-E 5 times during the program. Additionally, teachers were assessed on their abilities to conduct action research through interviews and questionnaires. Observations were made of teachers classroom practice and of their implementation of action research. Researchers supported teachers in their efforts to conduct action research through classroom visits and monthly workshops held at school sites. Implications are made for professional development of NOS, as well as for teaching NOS to elementary students.

George Akom	Renee' Schwartz	Brandy Skjold	HangHwa Hong
Fang Huang	Robert Kagumba		

A change in perspective: Science education graduate students' reflections on learning about NOS P-647-1266-1265-1297

Research emphasizes requirements of NOS knowledge, pedagogical knowledge, internalized beliefs in the importance of NOS, and intentional translation of this knowledge into explicit/reflective classroom instruction. Science educators conduct much of this research targeting K-16 arenas. Yet, a gap exists in the literature with respect to understanding how science educators come to their own understanding of NOS, NOS research, and NOS teaching. For systemic reform, graduate programs in science education need to provide NOS learning

opportunities for future scholars and teacher educators. This study describes experiences of five science education graduate students learning about NOS content, pedagogy and research throughout one year of their graduate program. We explore key turning points as they developed

personal orientations toward NOS. The change in perspective experienced by these students was multifaceted.

Konstantinos Alexakos

Science Teacher Adaptation and Marginalization P-57-111-110-147

Through in-depth interviews, in this paper I examine themes that frame and mediate the adaptation to the school environment by five in-service science teachers. This process of adaptation is seen as being framed and mediated by personal motives and ideals, as well as by the school culture they engage in. I argue that it is comprised of interconnected personal and cultural elements of rewards and tensions in rapport and in contestation with one another.

This study explores and describes such themes and aspects, with a discussion on how some traits and qualities may be welcomed while others not.

Ibrahim AlMomani Suhair Jaradat

Elementary Science Teachers Perceptions of Educational Reform in Relation to Science Teaching in Jordan P-139-226-225-262

This study aims at evaluating elementary science teachers perceptions of the educational reform movement with regard to their teaching practices. Data were collected from 78 elementary science teachers by means of open-ended questionnaire and interviews. Analysis of responses

indicated that teachers see reform as a necessity but they lack a real common understanding of the purpose of the reform in relation to their science teaching practices.

Nonye Alozie Joseph Krajcik

Educative Curriculum Materials to Support the Teaching of Modern Genetics P-206-1345-1344-1376

Studies in molecular genetics is growing and becoming an increasingly important topic in schools. Due to the inadequacy of traditional textbooks, a project-based approach to the teaching of genetics involves the learning of proteins and their relation to genes and phenotype. A reformation in curriculum materials to address this issue requires additional supports in educative curriculum materials for teachers. This study, which is based on design heuristics put forth by Davis and Krajcik (2005), uses videotapes of classroom enactment and an analysis of the current teacher guide to identify areas in high school genetics curriculum materials that are in need of extra educative features. Video analysis illustrated that although the teacher guide provided teachers with suggestions of adaptation techniques and rationales behind the suggestions, the there was still difficulty in enacting the curriculum. In addition, recommended activities addressed PCK for science topics and SMK, with very little dealing with PCK for science inquiry. Teachers need better support in enacting a project-based genetics curriculum, as indicated by this study, and a revision process will provide teachers with additional suggestions that will expand their repertoire in PCK and SMK.

Elvan Alp Esme Hacieminoglu Hamide Ertepinar

Pre-service Teachers Intended Emphasis on Teaching Environmental Issues P-321-555-554-591

The purposes of this study were to determine pre-service teachers attitudes toward the environment and the relevance of science with Environmental Education (EE), self-efficacy beliefs on teaching EE, and their intentions on teaching EE, and to investigate the effect of grade

level and attended Faculty of Education on pre-service teachers attitudes toward the environment and the relevance of science with EE, self-efficacy beliefs on teaching EE, and their intentions on teaching EE. The participants of the study were a total of 569 pre-service elementary science (ESE), and early childhood education (ECE) teachers enrolled in an undergraduate program at two different randomly selected public universities in Ankara, Turkey. Environmental Attitude Scale and The Questionnaire of Teachers Perceptions of Teaching Environmental Issues were administered. Two-way Multivariate Analysis of Variance was conducted in analyses. The findings revealed that pre-service teachers attitudes toward the environment and the relevance of science with EE were favorable. However, pre-service teachers showed low self efficacy beliefs on teaching EE. In terms of grade level

it was observed that as the grade level increases, the pre-service teachers attitude toward EE, the relevance of science with EE, self-efficacy beliefs on teaching EE, and their intentions to teach EE also increases.

Steve Alsop Sheliza Ibrahim

Acts of emotional compliance and deviance: rendering visible contrasting emotional boundaries in elementary science classrooms *Q*-759-1004-1003-1037

The proposed paper reports data collected from a 2 year ethnographic study of five science classrooms (two grade 6, two grade 7 and one grade 8). From a socio-cultural perspective, using digital video ethnography, we document episodes in which emotional traditions are co-constructed in elementary school science. Drawing on the seminal work of Hochschild, our study adopts an 'emotional-management' perspective in which particular emotions are rendered appropriate to a given situation (in our case the teaching and learning of science in a grade 6 integrated and in a grade7/8 laboratory setting). Our evolving argument is one of: (a) representation, (b) difference, and (c) action: representing the emotional codes of learning science and the differences between what it might mean to study science in our grade 6 and grade 7/8 contexts, and how our group of collaborating teachers respond to this analysis of their practices. The focus of study (the social construction of affect), the setting (grade 6 and 7/8 science classrooms), the evolving methodology (digital video ethnography and weblogs) and the type of study (quasi-comparative) make this proposal, we believe, unique. We suggest that our discussions are fruitful to researchers and educators wishing to better understand teaching, learning, affect and transition in elementary science education.

Annemarie Andersen Søren Dragsted Robert Evans Helene Sørensen

Capability Beliefs, Teaching Contexts and the Retention of New Danish and American Elementary Teachers of Science

P-221-363-362-399

This study's overall goal was to examine the relationship between teaching contexts of three cohorts of new elementary science teachers in Denmark and two in the US and their personal capability beliefs. We tested the belief that teaching environments are associated with self-

efficacy and consequently perhaps with longevity in teaching by measuring environmental circumstances and self-efficacy and seeing if the teachers were still teaching science after a few years. In Denmark, we found that high context assessments were associated with greater positive

changes in self-efficacy from the pre-service measures until the end of the first year and that those with negative changes were more likely to not continue to teach science in the following years. The self-efficacies of a group with special training for science were significantly higher than those of an earlier group and consequently, they were more likely to continue as teachers of elementary science. The qualitative US results show patterns similar to those in Denmark. This study's suggestion that pre-service training can increase the self-efficacies are associated with greater success and perhaps there is also a relationship to retention.

Janice Anderson Michael Barnett Heidi Sardina

The Kids Got Game: Using Quest Atlantis, a 3D Virtual Computer Game, to Develop P-530-972-971-1005

Computer/video games have been used in classrooms to promote learning and engage students to help them make sense of the world they live in (Williamson et al, 2004). They can be used to promote higher order thinking and learning through interaction and dialogue during the course of play (MacDonald & Hannafin, 2003). This type of learning demonstrates a constructivist approach (Vygotsky, 1986) where learning occurs when individuals take knowledge from a

situation, such as a computer experience, and assign personal meaning to it. This proposal describes a pilot study developed in collaboration with the faculty and staff at Chamberlain Middle School, in a small urban community. The purpose of this work is to study the implications of using a 3D virtual computer game to develop critical thinking and problem-solving skills in an eighth grade science classroom studying water quality.

David AndersonGregory ThomasSamson NashonSocial Barriers to Engaging in Meaningful Learning in Biology Field Trip Group Work

P-606-1399-1398-1430

This paper examines a sub-set of under-recognised and under-appreciated barriers that can prevent students engaging in meaningful learning and deploying higher order thinking skills as they engage in group work in field settings. The use of collaborative group work as a

pedagogical practice for promoting learning in such settings (and in classroom settings) is well founded and justified. There are several factors that teachers consider when constituting groups that will work effectively on collaborative learning tasks, for examples gender, prior knowledge or perceived expertise, positive interdependence, capacity for collaboration. This study

demonstrates that, even among highly collegial/collaborative student groups which are deemed effective by teachers and are constituted in ways consistent with the literature on effective collaborative group work, there exists underlying meta-social factors that influence and shape cognition. These meta-social factors have the capacity to circumvent meaningful learning. Science teachers very often under-appreciate the extent to which students are self-aware of their roles and the roles of others within groups, and their capacity for this awareness and sense of self-role within the group to influence cognition in both positive and deleterious ways.

Leonard Annetta Shawn Holmes John Park

Middle Grades Teacher Self-Efficacy Toward Learning Science and Integrating Video Games into The Curriculum P-568-1269-1268-1300

Magnets are commonly used around homes. Magnetism is a popular topic in elementary schools, and magnets and the behavior of magnets are included in local, state and national science education standards. This descriptive study addressed the question: are inservice elementary teachers prepared to teach fundamental concepts of magnets and the behavior of magnets? A set of five multiple choice tasks with popular non-scientific conceptions embedded in the distracter options was the primary source of data. In addition, an explanation of each multiple choice selection was requested, as was an indication of the level of confidence with which the selection was made and an explanation provided. The non-random sample consisted of 20 inservice elementary teachers from central Appalachia. Results, discussed by task, reveal the teachers as a group were not adequately prepared. For the five multiple choice tasks combined only 51 of 100 responses were correct. Further, the explanations provided indicate many of the 51 correct responses were false positives. More specifically, several correct responses seem to have resulted from guessing and non- scientific reasoning. Serious implications for both preservice and inservice teacher education are discussed

Xornam Apedoe Christian Schunn

Investigating the Tacit Problem-Solving Strategies of Novice Designers: Implications for Science Teaching and Learning Q-713-1475-1474-1505

Although research suggests that engaging students in design-based learning can be effective for learning science, more research is needed to understand how to most effectively facilitate this process for students. For those students who either struggle or are highly successful in this type of learning environment, what types of problem-solving strategies do they use to approach these design tasks? Understanding the ideas and strategies that students bring with them to the classroom environment has important implications for the design of curricula and classroom instructional practices. This study is a first step at exploring the problem solving strategies thatstudents use, and the relationship of these designerly problem-solving strategies to students learning of science when engaged in design-based curricular activities.

Nina Arnesen Doris Jorde

PISA+ - a Norwegian video study. A closer look at dialogue in science classes P-140-756-755-790

The Norwegian TIMSS and PISA results from 2003 resulted in the creation of a classroom video study to help explain declining results. PISA+ (Project on Learning and Teaching Strategies in School) is an indepth (over 3 weeks at each location) video study of mathematics, science and language arts in six schools with six classes of students. Advanced video techniques have allowed for analysis of classroom events, focus groups as well as interviews of students about incidents immediately after instruction. This paper reports on results from science lessons. Quantitative results of classroom pedagogical practices using the software program Videograph® show that science instruction tends to be whole class compared with mathematics and language arts. Analysis of classroom dialogue in science lessons together with student interviews has uncovered three types of science dialogue: Teachers using scientific language and students doing the same, teachers using scientific language while students translate into everyday language and both teachers and students using everyday language. The last type is most prevalent. Types of language used are related to types of pedagogical practice found in science classrooms.

Isaak Aronson

Negotiating Contradiction: Biology Instruction in a High-Stakes Environment P-109-181-180-217

Because only biology will be tested on the High School Assessment (HSA), high school biology classes should be most affected by the new high-stakes test and the curricular restructuring accompanying it. The 2006-2007 academic year is a critical time to examine the effects of No Child Left Behind before the high stakes officially become attached to the HSA in the following two years. Insights from the study could be used to improve the biology curriculum before schools, teachers, and students suffer major penalties for non-proficient level test results. An open-ended questionnaire is used to assess the effects of accountability on science instruction in a school district. Four general questions guide the study of biology instruction in Montgomery County. How well is the curriculum aligned with state standards, the biology section of the HSA, national science education standards, and scientific inquiry-based instruction? How do high-school biology teacher conceive the discipline of science and scientific inquiry-based instruction? How do high school biology teachers negotiate competing signals (if any) on science education in their practice?

Bijaya Aryal Dean Zollman N.Sanjay Rebello

Facilitating Transfer Through Physical Models: A Teaching Interview on Positron Emission Tomography (PET)

P-641-1250-1249-1281

The objective of this study was to investigate the role of the physical models in transferring physics ideas to understanding positron emission tomography technology. Sixteen students enrolled in an introductory physics class participated individually in two sessions of a teachinginterview setting. A phenomenographic approach was adopted to analyze the videotaped interview data. A resource-based theoretical framework was used to examine transfer of learning. We noted that many students transferred their reasoning from prior experiences in inappropriate ways. Our results indicate that physical models are effective in triggering appropriate transfer provided that the models are introduced in a particular sequence. Given the appropriate sequencing of the activities, we find that the transfer of abstract ideas is facilitated through interactive learning with the aid of physical models. We identified three kindsof non-scaffolded transfer which we refer to as spontaneous, semi-spontaneous and non-spontaneous transfer in this study.

Anila AsgharBrian AltersScience is in Our Brains and Religion is in our Blood : Muslim Teachers and Scientists Conceptions of
Biological Evolution and Evolution Education
P-95-939-938-972

This study seeks to explore the intersections among religion, science, and education in diverse Islamic countries and cultures. Specifically, it examines the ways in which the scientific theory of evolution is understood by Muslim university faculty and high school biology and science teachers in light of their Islamic belief of creation since very little is known about the evolution/creation controversy in the Islamic world. Data was collected from 25 high school science teachers and 14 scientists and professors from various schools and universities in Pakistan and Canada. Qualitative interviews and focus group discussions were conducted to probe participants' epistemic understanding of evolution and how they address the evolution/creation controversy in teaching. Canadian and Pakistani Muslim science teachers mostly accepted evolution of living beings except human beings because human evolution contradicts their Islamic beliefs. The science teachers mostly lacked a clear understanding of biological evolution. Most were in favor of teaching the religious and scientific perspectives in their science courses. Muslim scientists generally did not perceive any major conflict between Islam and evolution theory; most tried to reconcile evolution with religion. This study has implications for teacher development and science education; Muslim science teachers need better training opportunities in evolution education.

Doris AshJennifer DeWittJustin DillonJill HohensteinJane LehrResearching Language, Learning and Engagement in Informal Science InstitutionsS-207-341-340-377

This symposium reflects the 2007 conference theme, by examining efforts to enhance studies of science education through research focusing on the role of language, argumentation and discourse. We note, for example, the relationship between the shift from public understanding of science to public engagement, and its impact on the nature of research in science education. Similar theories inform our research, specifically those noting the centrality of discourse in social interactions.

Paper 1 looks at the relationship between the language and learning on field trips. Drawing on Cultural Historical Activity Theory and theories of motivation, a framework was developed to guide the creation of resources for school trips. Paper 2 examines the use of labels to generate learning conversations in museums. Paper 3 describes the creation and use of a newly developed analytic tool designed to capture both everyday and academic science discourse for analyzing scientific talk, over time, of families as they visited a marine science center. Paper 4 examines the role and value of dialogue events as sites of learning. The team's experiences as practitioners and researchers/evaluators were used to develop a framework for research into the role, value, and practice of dialogue events.

Ronald Atwood John Christopher Rebecca McNall

Are Inservice Elementary Teachers Prepared to Teach Fundamental Concepts of Magnets and the Behavior of Magnets?

P-586-1114-1113-1147

Magnets are commonly used around homes. Magnetism is a popular topic in elementary schools, and magnets and the behavior of magnets are included in local, state and national science education standards. This descriptive study addressed the question: are inservice elementary teachers prepared to teach fundamental concepts of magnets and the behavior of magnets? A set of five multiple choice tasks with popular non-scientific conceptions embedded in the distracter options was the primary source of data. In addition, an explanation of each multiple choice selection was requested, as was an indication of the level of confidence with which the selection was made and an explanation provided. The non-random sample consisted of 20 inservice elementary teachers from central Appalachia. Results, discussed by task, reveal the teachers as a group were not adequately prepared. For the five multiple choice tasks combined only 51 of 100 responses were correct. Further, the explanations provided indicate many of the 51 correct responses were false positives. More specifically, several correct responses seem to have resulted from guessing and non-scientific reasoning. Serious implications for both preservice and inservice teacher education are discussed

Line Augustine

Enactment of chemistry knowledge by a high school student in a summer program *P*-173-1412-1411-1443

This paper describes the outcomes of an ethnographic study of the development of the chemistry knowledge of a high school student at a summer program, and the influence of a cultural practice, othermothering, on her ability to perform well on her chemistry Regents Exams. Over the course of the study, Kelly, an 11th grade student, exhibits understanding of concepts and practices addressed within the laboratory period and tutoring sessions. In these fields, she is an effective collaborator and exhibits great care and concern for her peers. The level of understanding that Kelly demonstrated when participating in the laboratory and tutorial sessions were not reflected on practice high stakes exams taken during the summer program. This study investigates the exhibition of chemistry content knowledge in the laboratory and the absence of such knowledge on standardized exams. In this study, I utilized Sewell s theory of cultural sociology (1992) to search for patterns of coherence and contradictions, as they relate to events that unfold in all social arenas that involve science. I used these patterns to understand the roles of the structures of the laboratory and exams on Kelly s ability to be agentic in the enactment and production of her chemistry knowledge. Throughout this study, I uncover that the role and culture of other- mothering, that is demonstrated by young girls such as Kelly, within an academic setting, can prove favorable in these students enacting their scientific knowledge. Furthermore, I show how a young Latina was able to use such a role to be efficient within a chemistry laboratory.

Barbara Austin Michael Pullin

The Differential Benefits of Participation in Research Experiences for Undergraduates (REUs) as a Function of Carnegie Classification of Home Institution P-323-558-557-594

This study presents findings from interviews with and observations of thirteen undergraduates involved in National Science Foundation-funded, interdisciplinary Research Experiences for Undergraduates (REUs) at a small science- and engineering-focused institution. Qualitative data about undergraduates understanding about the nature of science and how they were learning to do cutting-edge research were taken throughout the program. Quantitative data about the nature of what they did for the program was taken at the end. Qualitative findings show that students have little knowledge of what scientists do and the nature of science. Even though they intended a research-based career, students from non-research institutions had almost no knowledge about the nature of university-based, scientific research. Quantitative findings show that REU students are engaged in experiences that mirror first and second year graduate students.

Lucy Avraamidou

Carla Zembal-Saul

Classroom-based inquiry: Two beginning teachers' knowledge and practices for science teaching Q-87-505-504-541

The purpose of this study was to explore the nature of two first-year elementary school teachers practices, knowledge and beliefs, and identify the probable sources from which their knowledge was generated. This study is grounded in research on teachers practices, knowledge and beliefs and is informed by cognitive constructivist and sociocultural theoretical perspectives of learning. Andrea and Jean, two first year teachers that went through an innovative preparation program were the participants of this collective case study. For each of them data included three audio taped interviews, six videotaped classroom observations, lesson plans, and samples of students work. The information yielded from the analyses showed that both of them initiated inquiry-based practices, however, they differed in the emphasis placed on different aspects of teaching. Those aspects for Jean were a) engaging students in inquiry-based investigations, and b) writing in science in the form of claims and evidence. Andrea placed emphasis on: a) supporting students learning through inquiry-based activities and b) assessing students learning. This type of study adds to the literature of teachers practices, knowledge and beliefs, within the domain of research, practice and policy by providing two concrete examples of reform-oriented instructional practices.

Carlos Ayala

Validity of educative design heuristics applied to SEPUP: Scaffolding teacher learning P-469-1141-1140-1173

The purpose of this study was to review an existing and well-known issue-based science curriculum developed by the Science Education for Public Understanding Program Lawrence Hall of Science (SEPUP) using nine educative design heuristics. Educative curriculum materials are those that support teachers with student learning and also increase teachers pedagogical and content knowledge. A science education researcher and an expert middle-school science teacher reviewed two SEPUP units: Earth in Space and Plate Tectonics and later presented our findings to the curriculum developers. We found that the application of the design heuristics illustrated the strengths and worth of the curriculum; while discussions about the teacher s guide materials surrounded around the scope and usefulness of the teacher materials themselves vs. ancillary materials, and professional development. Finally we found that the curriculum had both instances of educative elements and missed opportunities to be educative. We also found that the design heuristics did not all apply to each lesson or unit (level of analysis problem), that there may be a heuristic missing about student learning strategies, and that certain heuristics were more appropriate for different lessons or units of the curriculum. Overall, the design heuristics provided a useful tool to tease out the tensions of curriculum development tensions versus the needs of practioners in a well established and renowned curriculum.

Mehmet AydenizNancy DavisSherry SoutherlandPenny J. GilmerUnderstanding the Nested Relationship between Teachers' Epistemic, Pedagogical and Assessment ConceptionsP-354-614-613-650

The focus of this study is to examine the extent to which high school science teachers are prepared to enact ssessment reform as described by social constructivist accounts of assessment in science classrooms. Collecting data through teacher interviews, classroom observations and document analysis, this study focuses on the challenges to the implementation of assessment reform in science classrooms. The findings center on how the teachers' epistemic views of science, their conceptions of school science and their pedagogical conceptions influenced their conceptions and practices of assessment. Findings suggest a nested relationship between teachers' epistemic views of science, their conceptions of school science, their pedagogical conceptions and their conceptions of assessment. This nested relationship shaped how teachers approach the assessment of students' learning in science. As implications of these findings, we focus on the changes that might be needed to reduce tensions between teachers' conceptions and practices of assessment, and assessment conceptions and practices that the prominent science education reform documents advocate. Finally, we discuss the ways in which teacher educators may be able to assist science teachers to use assessment methods that will reinforce the goals of science education reform documents, using PCK as a discussion framework.

Elizabeth BabcockJudith LedermanNorman LedermanChanges in Biology TeachersAttitudes and Behavior Toward Informal Learning Sites: An Urban Case StudyP-703-1452-1451-1483

Museums are unique learning environments that have the potential to reinforce and extend school-based learning. However, effective teaching with museum resources requires teacher education and practice integrating these resources into classroom agendas. In this research project, a Midwestern natural history museum and a research university partnered to create and deliver a museum-infused biology curriculum and professional development training to inner-city, ninth grade biology teachers. Using both qualitative and quantitative techniques to document impact, this project resulted in significant increases in teachers utilization of museum resources. Teachers improved their skills in three areas: integrating museum resources into lesson plans, designing inquiry based lessons using museum artifacts and specimens, and creating focused field trips that linked classroom agendas to exhibition experiences. Teachers interest levels in using museum experiences also increased. The researchers found that while most of the teachers improved their practice as a result of this professional development program, teachers at schools with moderate student performance levels demonstrated the greatest degree of change in their usage of museum resources. This research provides a model for how to structure a professional development program that links classroom-based instruction on scientific inquiry and the nature of science to the use of museum resources.

Minjung Bae

Lesson Planning Activity as a Tool to Assess Pre-service Teachers' Knowledge and Skills in Using Curriculum Materials

Q-192-1365-1364-1396

Various assessments, which have been usually used in educational research, have limitations for teacher educators to use when assessing pre-service teachers' knowledge in using curriculum materials. This paper explores the potential of lesson planning activity for a tool to assess pre-service teachers' knowledge and skills in using curriculum materials. In particular, it provides rubrics for assessing pre-service teachers' lesson plans and the results of the assessment focused on their use of instructional models and Project 2061 Instructional Criteria. In the pre-test, 73% of pre-service teachers from three elementary science method sections created lesson plans including didactic and hands-on components, and almost all pre-service teachers' lesson plans did not meet Project 2061 instructional criteria well except for a few criteria. In the post-test, more pre-service teachers created lessons including components of conceptual change model or inquiry approach, but still others did not use or misapplied the models. Also, although there are differences among sections, pre-service teachers' lesson plans seemed to better meet the Project 2061 Criteria. This result is triangulated with other data source. Though limited, this study suggests using lesson planning activities as an alternative assessment to assess pre-service teachers' knowledge and skills in methods courses.

John Baek Qing Xia Erin Peters Patricia Martinez Brenda Bannan-Ritland Margret Hjalmarson

Design research on the means of support for teaching and learning geological observation P-224-368-367-404

The purpose of this study was to design the instructional support for teaching and learning geological observation. The design of this study follows a line of inquiry called design research. Design researchers both engineer particular forms of learning and systematically study them within the context defined by the means of supporting them. The objective of this paper is to abstract the design principles that were used to design the means of support to learn geological observation. Using this design research methodology may help us to answer the research question: how do we design science instructional materials to support the teaching and learning of geological observation? The data for this study was collected over a two year period of afive-year project over two phases of design work. In the retrospective analysis we present three design principles that could be used to develop instructional materials that support the teaching and learning of geological observation? I) Start with a scientifically literate event, 2) designwith classroom constraints, 3) use flexible technologies. By capturing the scientifically literate event into a sharable, flat object at a classroom-friendly scale, we found that novices can learn from them through efficient interpretation.

Dale BakerSenay YasarMichael Lang

The Communication in Science Inquiry Project (CISIP): Lessons Learned from Professional Development with Secondary Teachers

P-308-535-534-571

The Communication in Science Inquiry Project (CISIP) is a Teacher Professional Continuum project funded by NSF (award # 0353469). It provides professional development to science and English/ESL teachers who work together to create inquiry-based science modules. The model integrates oral and written discourse, academic language development, and learning principles to promote conceptual understanding especially for English language learners. Evaluation consisted of classroom observations and follow-up discussions with teachers testing the modules. We found that lessons focused on those aspects of the model that were best understood and avoided aspects of the model that were not seen as part of teaching science. We concluded that in order to integrate all components of the CISIP model there should be fewer lessons focusing on key aspects of the model. Lessons should include meaningful writing that promotes maximum understanding. Lessons should be more flexible including multiple starting points based on students prior knowledge, language proficiency and academic ability. Academic language development should be reframed to include all students. Professional development should be revised to increase the focus on: 1) writing, discussion, metacognition, and academic language development in learning science; 2) learning principles; and 3) strategies that moved the model into practice.

Brian Baldwin

Reflective Practices of pre-certified, inservice teachers within an electronic portfolio P-389-683-682-717

Research was conducted on the reflective practices of teacher candidates in an electronic portfolio submitted as a graduation requirement from a graduate-level teacher education program geared towards career-change adults. Previous research on reflective practices and the nature of reflection and professional growth is rooted in the early work of John Dewey. This research investigated the teacher candidates perceptions of their professional reflections, as well as the perceptions of the program faculty on the purposes and format of the candidates reflections. Results indicated four main themes in the reflective pieces: (1) artifact selection, (2) nature of reflective practices. The findings show that regardless of the unique nature of the individual candidates professional reflections, commonalities between portfolios of different teacher candidates are prevalent due to the prescriptive nature of the requirements for the portfolio. The candidates reflective pieces are written to address the program standards and were often filled with educational jargon written for the intended audience: program faculty. Despite the individuality between the reflective pieces, the process of selecting and compiling the artifacts to be included in the portfolio was itself a reflective practice, enabling the candidates to discover their own professional growth as learners and practitioners.

Meena Balgopal

How reflective writing reveals cognitive and affective alienation and affiliation in a college biology course Q-632-1243-1242-1274

Undergraduate reflective essays, written in response to different types of prompts, were analyzed using grounded theory methodology. Zoology majors were given a choice between responding to a specific prompt (directed essays) or to chapters of an assigned book (non-directed essays) as part of an ecology course. Essays were intended initially to give the researcher insight into the process of student learning as part of a larger study on conceptual change; however, it emerged early in the study, through the constant comparative method, that writing was an important activity that affected learning. The Writing to Learn literature supports this finding. Through triangulation of data (class observations, test scores, essays and semi-structured interviews) and of theoretical analyses (symbolic interactionism and social constructivism), students in both the directed and non-directed groups could be classified into four categories of writers (subjective, objective, authentic and detached) based on levels of cognitive and affective affiliation or alienation from subject matter. Case studies representative of each of the four categories were developed, along with one anomalous case in which the instructor and researcher disagreed on student affiliation. It was concluded that student learning and identity-formation are interrelated and may influence how students learn science.

NARST Annual International Conference 2007

Martin BalinskyNancy DavisPenny GilmerDonna GrangerScientists learning science: A collaborative partnership between science doctoral students and K-8 science teachersS-331-1135-1134-1167

The GK-12 Fellows' program is an NSF-funded program aimed to connect science graduate students with K-12 science classrooms. At our university Fellows were primarily doctoral students in three-year cohort. GK-12 Fellows spent their first semester in a Teaching/Learning Science course. Assignments alternated between elementary/middle school, and between school types. We have a rich ethnic mixture of Fellows. Some Fellows and one PI spent three weeks in Australia with local K-12 teachers. We discuss Fellows' learning of science and teaching in their classrooms and in Australia. We gathered qualitative data in the form of surveys, interviews with a number of the Fellows, videotaped visitations to Fellows in their classrooms, and transcripts of our monthly meetings. One of us conducted in-depth case studies of four Fellows. We compared them to peers outside of GK-12. We analyzed our findings through the use of integral theory, moral structural theory, structure, agency, and culture, and border-crossing. For Fellows the starting point for their learning about pedagogy/science was admitting what they did not know. Fellows modeled learning to students and developed the ability to locate information. They learned to draw on resources from science departments and to think across the curriculum. We identify key issues in scientist/teacher partnerships, potential improvement of college science teachers and global information exchange among science educators.

Yael Bamberger Tali Tal

Outcomes of Students' Long Term Learning in a Class Visit to a Science Center P-369-647-646-683

The purpose of this study was to describe and understand the range of short and long term learning outcomes of one class visit to a science center. The theoretical framework is based on three criteria for evaluating meaningful learning: connecting knowledge, communicating knowledge and coping with knowledge. The significance of the study appears by focusing on several possible learning outcomes rather than only on the cognitive gain and the change of these outcomes during a long period of time. We investigated one 8th grade class visit to a science center, and interviewed 13 students in school on the following day. Sixteen months later, we interviewed 21 students using the same interview protocol, even though nine of them had been interviewed before. The short and the long term interviews were analyzed according to three main categories which addressed meaningful learning outcomes: connecting knowledge, communicating knowledge and coping with knowledge, which then were classified into subcategories according to the students statements. Our findings indicate that during the 16 month period some changes in these domains occurred,. This highlights the significant educational values the students take to their lifelong journey from the informal learning experience.

Anil Banerjee

Invited related paper sets: Enhancing student learning in chemistry P-273-1616-1615-1645

The research with 50 students in an introductory chemistry course in Spring 2006 at Columbus State University indicated that peer-led tutorial sessions in addition to the regular lecture classes helped student learn chemistry concepts better and improve scores by more than 10% in each tests and final exam. The same class freshman peer-tutors were high ability and motivated students from the same class chosen on the basis of content pretest and interview. Though the tutors were not trained, the instructor had regular discussion with these peer-tutors on problems and strategies to be used in the tutorial sessions. The project is being continued in a more massive and intensive scale in fall 2006. The major focus of this project is to generate data on how freshman students work as peer-tutors for students of the same class under the concept' Freshman teaching freshman'. The results, strategies and experiences from both spring and fall 2006 classes will be presented.

Bongani Bantwini, Barbara Hug

Teachers Perceptions of the New Science Curriculum Reforms: Lessons from elementary school teachers from one school district in South Africa P-509-1429-1428-1460

This paper discusses elementary school teachers perceptions of the new science education curriculum reforms in one school district in South Africa. The study used questionnaires, in-depth interviews, as well as workshop and classroom observations as data sources. Data analysis followed the open coding and axial coding process (Burnaford et al., 2001). Findings of the study revealed most teachers had negative perceptions of the new science curriculum reforms. Several internal and external school factors that contributed to their perceptions were: inadequate view and understanding of the reforms; issue of current workload vs. the new reforms; inadequate support from both school administrators and school district; lack or poor curriculum implementation in classrooms. This study recommends steps that would help change the situation in the school district.

Mónica BaptistaAna FreireDeveloping Linguistic Competencies while Teaching Sound to 8th Grade PupilsQ-178-288-287-324

Concern about the quality of science instruction has reached the centre of discussion in Portugal. The ensuing national debate culminated in a reform of science teaching for Middle School which has a constructivist focus, values the scientific inquiry approach, promotes the Science-Technology-Society perspective and specifies competencies of knowledge, reasoning and communication and scientific and social attitudes. The new curriculum pushes the teachers towards new teaching approaches. It seems important to know how the 8th grade pupils overcome the difficulties and the kind of competencies that are being developed when they are involved with inquiry activities. This study is part of an extended one that involved schoolteachers implementing new activities. The research reported is qualitative, adopting an interpretative orientation. It shows the pupils difficulties when studying the sound properties by reading a text and after investigating it using different material experimental. All the lessons are audio taped and written documents are produced. The written documents and the verbatim transcripts were content analysed. The findings show the pupils difficulties in text interpretation, writing conclusions after the practical task and explaining the phenomena observed. It is important to create learning situations that promote linguistic competencies if we want to contribute to scientific literacy.

Ayelet Baram-Tsabari Anat Yarden

Interest in biology: A developmental shift characterized using self-generated questions P-45-92-91-128

Positive relationships have been reported between individual interest and a wide range of indicators of learning. However, the potential benefits of motivation for school reform have been largely ignored. Most of the attempts to identify pupils preferences for topics in science relied on adult-centric views of what subjects should be meaningful to students. To overcome this inherent bias, we developed a naturalistic approach to defining specific interests in science by using self-generated questions. In a classroom setting, it is hard to use children s questions, since they are so rare. Therefore, to identify interests in the field of biology among different age groups and between genders, we collected questions for this analysis from informal science-learning sources. An analysis of 1751 self-generated biological questions raised by children, adolescents, and adults indicated that the popularity of certain biological topics varies with age and gender. Significant differences were found between the motivations of different age groups and genders to ask biological questions. We also found that the relative frequency of zoology questions decreased with age, as the proportion of questions relating to human biology increased. Research limitations are pointed and applications for teachers and researchers are discussed.

Sarah Barrett Martina Nieswandt

Teaching Science for Social Justice Through SSI: Teacher Candidates Beliefs P-56-253-252-289

Including socioscientific issues (SSI) in the teaching of science can be a method to introduce social justice issues into science teaching. However, this is not the traditional approach to science teaching. As teacher educators, we know that teacher candidates arrive in our classes with fairlytraditional beliefs. In order to change them, we need to have an understanding of those beliefs. This qualitative case study followed twelve preservice science teacher candidates who were enrolled in a 9-month teacher education program and attempted to ascertain their beliefs about including SSI in their teaching. Interview data was used to develop four ideal types of role models to which the teacher candidates aspired: Scientist/Engineer, Individual, Teacherand Citizen. Each type has ramifications for the way a teacher educator might approach encouraging his or her students to include SSI in their teaching. We conclude that beliefs about teaching science for social justice through SSI derives from a complex web of fundamental beliefs represented by the ideal types described. Further, this study shows that the justification for belief change required by a particular teacher candidate depends on the type of teacher they wish to be in the future.

Nazan Bautista

Increasing Early Childhood Education Majors' Self-Efficacy Beliefs via Backward Design Q-706-1536-1535-1566

A great number of research studies found that elementary teachers avoid teaching science because they do not believe that they can teach it well. The major responsibility in helping preservice teachers become more comfortable in their abilities to teach science to young children is of science education programs. One possible way to achieve this mission is by providing teaching and learning opportunities that are designed to increase confidence level of preservice teachers, as they take the science methods courses. This study suggests a new course model for early childhood science methods. The new course model was designed based on the backward design framework and its effectiveness was evaluated by using Science Teaching Efficacy Beliefs Instrument (STEBI-B) before and after the new course implemented. Sixty preservice teachers participated in the study and based on the dependent t-test, the new course model significantly increased their confidence in teaching science.

Gillian Bayne

Dynamic membranes and porous boundaries: Utilizing cogenerative dialogues to explore the intricacies of equity and culture within the urban science laboratory P-173-1395-1394-1426

Science laboratory exposures and experiences are regarded as essential components of science education. Many involved in urban schooling, however, continue to struggle with maximizing the teaching and learning potentials they offer. In this study, I investigate how the utilization of cogenerative dialogues (Roth, Tobin and Zimmermann, 2002) affords a rich examination of teacher and student practices and interactions, while concurrently serving as seedbeds for the production of new culture. Salient vignettes, capturing social life as it unfolds within a series of ninth grade biochemistry laboratory experiments and activities, are analyzed through sociocultural lenses and provide innovative ways by which students and teachers ideas and behaviors may be explored. The goal of this work is to not only inform current teaching and learning practices, but to help transform them in ways that serve participants optimally. Pragmatic, critical qualitative research practices, which increase opportunities to learn and understand the dynamics of laboratory teaching and learning in urban schools, have been employed. Theoretical applications of the agencylstructure dialectic (Sewell, 1992), Collins (2004) notion of the sociology of emotions, and the examination of patterns of coherence and contradictions in participants actions, including body language and speech, all provide insights into ways by which urban students who have been historically alienated by science, make transitions from interacting peripherally in laboratory settings, to individually and collectively playing central roles in the cultural enactment of laboratory science work (Lave & Wenger, 1991).

Renee Beeton Genie Canales Loretta Jones

I could see myself as a chemist': An examination of the science identity formation in high school Mexican American girls

P-262-1148-1147-1180

Mexican Americans are a rapidly growing ethnic group in the United States. However, they are noticeably absent from physical science fields. Little research has been done to explore the experiences of Mexican American girls in high school chemistry. Multicultural feminism and situated cognition framed this case study that examined the science and chemistry experiences of nine Mexican American girls in high school chemistry experiences of nine Mexican American girls in high school chemistry experiences of nine Mexican American girls in high school chemistry. The focus of the study was to explore the formation of their school identities and how these identities have affected their attitudes towards high school chemistry and future science careers. The girls were observed in the chemistry classroom and participated in focus groups and in-depth interviews. Only three of the nine girls were found to have a positive science identity and this identity was dependent upon a positive college identity. Family education level and early childhood science experiences helped to promote these positive science identities.

Philip Bell Leah Bricker

'Um, since I argue for fun, I don't remember what I argue about. ': Using children's everyday argumentation across social contexts to inform science instruction P-718-1534-1533-1564

Because argumentation is a central practice in science, it should also be a central practice in science classrooms. Efforts to ensure its place in classrooms are gaining momentum but a more comprehensive understanding of what images of argumentation and argument-related competencies young people bring with them to their science classrooms is needed. In this paper, we report on a two-pronged study a cognitive ethnographic study followed by a design experiment. The study was designed, in part, with two goals in mind: (1) to investigate young people s understanding of argumentation and the argumentation practices in which they engage across the social contexts of their lives and (2) to leverage those understandings and practices in curricular and instructional interventions designed to engage young people with what it means to argue scientifically. We discuss the analytic tools we use, as well as the findings and implications the tools enable.

Philip BellMaisy McGaugheyCarrie TzouHeather ZimmermanExplorations in the cultural foundations of childrens images of science: Understanding the nature of
science is not enough
P-536-1479-1478-1509

This paper serves as the introduction to our related paper set, which asks the question: how do children come to understand science as a discipline and how do they learn what it means to act scientifically in their homes, communities and schools? In this paper, we introduce the everyday expertise framework that we use to study the cultural foundations of children's images of science. We use three interlocking analytical planes to study how children construct their understandings of science. We study children's images of science by analyzing the impacts of culturally-patterned activity systems on the development of children's conceptual ecologies of ideas about nature of science as they participate in peer and family ideocultures (Fine, 1983) that are co-constituted through discourse and interaction. We adopt this approach to counter prior research on cultural learning processes that essentialized findings to specific cultural groups or assigned learning traits to individuals from specific ethnicities. In contrast, by using the everyday expertise theoretical perspective, we use patterned everyday activities as the primary unit of analysis (cf. Cole & Engeström, 1993; Saxe, 1996), to allow for natural variance within and across culturally identified groups.

Marjorie BequetteFrances LawrenzJames AppletonDeena WassenbergPreliminary Analyses of a Nationwide STEM Teacher Recruitment and Retention ProgramP-670-1351-1350-1382

This paper presents the results of an initial evaluation of the Noyce Scholarship Program, a nationwide, federally funded science, technology, engineering and mathematics (STEM) teacher recruitment, education and retention program. The evaluation is grounded in an extensive review and categorization of literature on STEM recruitment and retention. Data have been collected through surveys from more than 50 teacher education programs across the nation as well as from observations and interviews at both virtual and face-to-face conferences. The data and the literature have been incorporated into Resources for Recruitment and Retention of STEM Teachers (R3), an online resource which includes a new searchable literature database, evaluation methods, policy briefs, and other information for academic researchers, administrators, policy makers, and providers who are interested in optimizing the effectiveness of STEM teacher preparation programs. This presentation will present R3 and provide information, from surveys, conferences, and feedback from practitioners, on the effectiveness of the Noyce Program which will be of interest to all those working to increase recruitment and retention of STEM teachers.

Cheryl Berg Jenefer Husman Wonsik Kim

Effect of Temporal Orientation and Perception of Instrumentality on Student Academic Performance P-699-1566-1565-1595

Educators are challenged to look for factors that have the greatest impact on student academic success, and create teaching methodologies and instructional activities that foster the development of those factors. This study examines the achievement of community college pre-nursing students in an introductory biology class for allied health professionals who are uniquely focused on developing knowledge to achieve their future career goals. This study investigates the effect of temporal orientation and perception of instrumentality on the academic performance of those students. Our research goal is two-fold: to understand the impact of an extended view of the future on students' perception of instrumentality of their science coursework; and to understand the impact of the student's perception of instrumentality upon their academic performance. Results from this study provide information about the relationship of future time perspective to perception of instrumentality; and the relationship between perception of instrumentality and student academic performance. The results of this study can be used to improve instructional practices, and reinforces the idea that the education process should include as much application to the real world as possible when teaching theoretical concepts, as well as attempt to point out the future importance of one's present behavior.

Joseph Berger Ted Britton Allan Feldman Jodie Galosy Anita Greenwood Morton Sternheim

The Alternative Certification of Science Teachers: Findings from the NSF-funded STEM ACT conference S-48-468-467-504

The purpose of this symposium is to report on the outcomes of an NSF-funded conference (STEM ACT) on the alternative certification of science teachers, and to provide a forum for discussion of those findings. The conference explored the issues that have arisen in science education as a result of the proliferation of alternative certification programs in the United States, and to identify the research that needs to be done to reconcile the rapid growth of these programs with the demands that national standards. A second focus of the conference was to address the question, 'What do we know and what more do we need to learn about how to incorporate the results of more than 30 years of research on science teaching and learning into alternative certification programs?' The symposium will present three white papers: research, practice, and policy. Ample time will be provided for discussion of the findings.

Elizabeth Berkes

A Qualitative Study of the Development of Undergraduate Self-Efficacy Beliefs in a Biology Laboratory Internship P-334-577-576-613

Although over 30,000 students have participated in undergraduate research internships in the United States, research into this phenomenon remains limited (Campbell, 2002, p. x). It is important to explore what types of laboratory experiences help to develop the skills, confidence, ways of thinking, valuing, and interacting that lead student researchers to view life science research as a viable career option. Using case study data gathered over a period of four years, this paper examines two practices in laboratories, strategy instruction and modeling, that were found to increase the self-efficacy beliefs of student researchers. This study has important implications for developing quality internship opportunities that lead to future participation in science. This presentation will also be of interest to NARST participants exploring the use of Discourse Analysis and ethnographic techniques in hybrid informal/formal science education settings.

Elizabeth Berkes

Mark Hogrebe

Undergraduate Laboratory Research, Persistence in Science, and the Effect of Self-Efficacy Beliefs: A Quantitative Study Q-334-785-784-819

As undergraduate laboratory research internships become more popular and universities devote considerable resources towards promoting this activity, it is important to understand the impact of these activities on the science pipeline and clarify what is being gained by students involved in these experiences. These data reveal three important findings. First, participation in lab internships results in increased interest in going on in life science/biology graduate school and careers. Second, a significant proportion of that interest is related to the students biology laboratory self-efficacy. Third, self-efficacy beliefs may serve as an important predictor of interest in future careers in some scientific disciplines. This study has important implications for promoters of undergraduate research internships as well as science education researchers interested in the role scientific self-efficacy plays in shaping student motivation to pursue scientific careers.

Warren Bernard

Authentic research projects: Pre-college students' perspectives P-289-486-485-522

Authentic research projects represent one type of inquiry activity and are a core component in science education reform movements (AAAs, 1993; NSES, 1996). The purpose of this study was to examine high school students perspectives of an authentic research project in the context of a local Science and Engineering Fair (SEF). In this qualitative study, demographic information was used for the purposeful selection of fourteen students comprising the study sample. Data were collected via an open-ended survey, three individual interviews, a web log, and a group interview and, subsequently coded. Emergent themes describing the students research experience included 1) the students reluctance to undertake the project, 2) difficulty choosing a topic and designing a study, 3) accepting ownership of their project, 4) growth of interest, 5) acknowledged benefits of the research experience, and 6) reflection on the experience. The implications of the study are two-fold. At the practitioner level, teachers should engage students in research as is called for in national and state level standards. For Science Educators, pre-service and in-service teachers, to be better prepared to work with students, need experience with authentic research during initial certification programs or professional development.

Joseph Beuckman N. Sanjay Rebello Dean Zollman

How does a Classroom Interaction System Affect Student Performance? P-629-1234-1233-1265

We have developed and deployed a Web-based wireless classroom interaction system in a large-enrollment introductory physics lecture class that uses HP handheld computers (PDAs) to facilitate real-time twoway student interaction with the instructor. Our system is ahead of other "clicker" based systems that are primarily limited to multiple-choice responses. Our system allows for a variety of questions including short answer questions. It also allows for adaptive questioning and two-way communication that provides real-time feedback to the instructor. We have demonstrated learning gains in our courses through use of this technology compared to earlier technology (PRS) used in the same class. We have also shown that students who use PDAs more often in class are more likely to perform better in the course.

Carrie Beyer Elizabeth Davis

Fostering Second-Graders' Scientific Explanations Using Educative Curriculum Materials: A Beginning Elementary Teacher's Perspective and Practice P-234-1183-1182-1215

Teaching science as explanation is fundamental to reform efforts but is challenging for many teachers, especially new elementary teachers. Despite the challenges teachers face, few studies have characterized the knowledge and practices teachers need in order to overcome these difficulties and the role that educative curriculum materials might play in facilitating teachers learning about explanations. To address these gaps, this study describes one beginning elementary teacher s perspective and practice for giving priority to explanations when she is provided with educative curriculum materials that are intended to support her in fostering those explanations. The analyses showed that in enacting the educative materials, the teacher developed a more sophisticated understanding of explanation, adopted learning goals that emphasized this inquiry practice, and developed three instructional practices to foster students explanation construction. However, despite this focus on explanations, she tended to emphasize the importance of learning science content above the importance of building explanations in her learning goals and instructional and assessment practices. This de-emphasis on explanations partially stemmed from the fact that she did not see this inquiry practice as an instructional strategy for facilitating students understanding of science content and as an educational goal in its own right.

Carrie BeyerCesar DelgadoElizabeth DavisJoseph KrajcikInvestigating Teacher Learning Supports in High School Biology Textbooks To Inform the Design ofEducative Curriculum MaterialsQ-234-533-532-569

Recent research in science education has found that educative curriculum materials are one potential vehicle for supporting teachers learning about reform-oriented practices. Educative curriculum materials include supports that are intended to promote both student and teacher learning. However, little is known about the extent to which existing curriculum materials provide support for teachers and the ways they can be improved. In this study, we reviewed eight sets of high school biology curricula to determine their potential for promoting teacher learning. We adapted the design heuristics for educative curriculum materials developed by Davis and Krajcik (2005) for use as our evaluation criteria. From this analysis, several themes emerged. First, the materials tended to provide support for teachers subject matter knowledge and pedagogical content knowledge for students ideas (e.g., misconceptions) but provided few supports for teachers pedagogical content knowledge for scientific instructional strategies (e.g., using phenomena and representations) and scientific inquiry. Second, the materials contained far more implementation guidance supports than rationales for instructional decisions. Finally, even though some materials contained many instances of support, these instances were sometimes pedagogically unhelpful and limited in detail. We present findings of the review and discuss implications for the design of educative curriculum materials.

Julie BianchiniEmily KangGregory KellyInvestigating Toxic Risk and Sharing Results On-line:What Do Preservice Science Teachers Know aboutScience, Inquiry, and Literate Practices?P-634-1231-1230-1262

We explored preservice science teachers views about science, inquiry, and scientific literate practices made visible through an inquiry investigation on toxic risk. We wanted to better understand how engaging in the social processes of inquiry provided opportunities to examine and discuss the rhetorical nature of scientific reports. In particular, we wanted to see what light an on-line anonymous peer review and publication component shed on preservice teachers conceptions of science and scientific inquiry. Thirty preservice science teachers at two universities participated. All completed the same assessing toxic risk inquiry investigation: They conducted a bioassay investigation to determine the toxicity of an everyday chemical of their choice, composed a draft report of findings, published this draft through an on-line anonymous peer review webpage, reviewed colleagues reports from different institutions, and revised their reports in light of reviews received. We qualitatively analyzed written reports, reviews, and open-ended survey questions to determine preservice science teachers understanding of inquiry processes, particularly as related to the development and refinement of their scientific arguments through peer review. Our intent was to inform science teacher educators on ways to deepen and broaden preservice teachers understanding of the nature, purposes, and methods of science.

Beata Biernacka Jazlin Ebenezer

Developing Grade 5 Students' Literacy in Science: A Teacher-Researcher Collaboration P-355-657-656-691

The goal of this study was to develop scientific literacy of grade five students in the context of a curricular unit on Weather. To fulfill this goal, a teacher-researcher team used the Common Knowledge Construction Model (CKCM), designed by Ebenezer and Connor (1998), and engaged themselves in a collaborative journey to develop three notions of scientific literacy--the 'what', the 'how', and the 'why' of science. It was an ethnographic, classroom based study, in which the researcher was a participant observer of all school endeavors. The data were collected by means of classroom observations, interviews, students' written work, maps and photographs. Subsequently, the data were coded to generate patterns and meanings pertinent to the students' and teacher's scientific literacy development. Qualitative evidence shows that the CKCM (specific contributions will be discussed at the conference) and the teacher-researcher collaboration contributed to the development of the three notions of scientific literacy of

grade five students in the context of a Weather unit. The findings of this study indicate that science educators and beginning teachers should engage in long-term, contemporary collaborative studies, which involve working with real students in authentic classroom situations.

Beata Biernacka Jazlin Ebenezer

Comparing Students' and Their Parents' Ideas about Weather: A Cultural Outlook Q-355-1344-1343-1375

The goal of this study was to find out grade five students' prior-teaching conceptions about weather and parallel them to that of their parents. It was an ethnographic, classroom based study, conducted in a grade five classroom (unit on Weather), in an inner city school. The school provided an ideal ground to serve and develop the goal of scientific literacy of all students. Students' ideas about predicting and measuring weather were collected by means of their written and oral responses. Parents' ideas were gathered by means of student parent interviews, which were transcribed verbatim by the researcher. Subsequently, the data were analyzed by the researcher to develop descriptive categories using Phenomenography (Marton, 1981).

The most obvious difference between the students' and parents' ideas about predicting weather was the parents' reliance on the 'old wise tales'. Both students and parents, however, had similar ideas in regards to measuring weather. It was also observed that students' ideas gradually changed as the study progressed. The findings of this study provide a framework for curriculum development with respect to a unit on Weather. They also offer insights about students' prior instructional ideas on weather and consequently frameworks for conceptual change.

Ian Binns Christine Schnittka Douglas Toti Randy Bell

Preservice Science Teachers Nature of Science Instruction and its Impact on Pupil Learning P-398-1339-1338-1370

The purpose of this study was to characterize preservice teachers nature of science (NOS) instruction during student teaching and determine how this instruction impacted their pupils understandings. Preservice teachers understandings of NOS and their intentions to teach it were assessed by the VNOS-C and follow-up interviews. Instructional practices related to NOS were assessed through lesson plans, classroom observations, and exit interviews. Pupil understandings of NOS were assessed through pre- and posttest administrations of a modified version of the VNOS-C and through exit interviews. Results indicated that the preservice teachers achieved desired understandings of NOS, that they developed strong intent to teach about NOS, and that they included explicit instruction on targeted aspects of NOS during their student teaching experiences. Explicit NOS instruction positively impacted their pupils understandings of NOS over the course of the study, with the greatest gains in their understandings of tentativeness, the role of inference in the development of scientific knowledge, and the difference between theories and laws. The results of this study are promising in that they indicate that beginning teachers can be taught to address NOS appropriately during student teaching, and that their instruction can have a positive impact on their pupils understandings.

Kathie Black Tanya Taft

Integrating Science Content, Language Arts, And Social Studies In A Special Relativity Unit For Grade 11 Students P-261-436-435-472

Curriculum integration is an important theme in discussions on school reform (Bullough, 1999; Erickson, 2001). Martin-Kniep, Feige and Soodak (1995) discussed that well thought out integration can help students to understand and appreciate dissimilar and complex ideas thereby helping to inspire students to focus and engage in new areas of thought (Hargreaves & Moore, 2000). The purpose of this work was to examine the integration of science content, language arts, and social studies into a special relativity unit for grade 11 students. A mixed methods research design was implemented to examine the effectiveness of this strategy. Significant gains were realized in student attendance, unit tests, and unit marks. Interview data with participating teachers and analysis of individual student writings gave interesting insights into student learning and perceptions of science content and understanding. There is a clear impact on achievement and attitudes of students through integration. This study demonstrates the benefits of working integration into curriculum in order to help prepare students more thoroughly for further studies and work in the real world. This study offers a practical and realistic method of curriculum integration in order to alleviate some of the present obstacles to this method of instruction.

Alice (Jill) Black

Earth science conceptual understanding of preservice teachers: Relationships with content exam success and spatial P-671-1597-1596-1626

Are the overall grades that preservice elementary/middle teachers make on science content exams related to their conceptual understanding of spatially-related topics, or to their spatial abilities? This study investigated the relationships among composite exam scores of 124 students enrolled over two years in an Earth Science for Teachers course and their scores on the PVOR, a test of mental rotation, and the ESC, a test of Earth science conceptual understanding, including both misconceptions and broader conceptual difficulties. The composite exam scores included all Earth science course content, regardless of whether conceptual problems were involved, and both written and lab practical exams. The ESC and PVOR were administered on both the first and last days of class. Curricula included hands-on and whole-body activities that stressed spatial aspects of the topics presented. Results showed significant positive correlations among all scores, with ending ESC scores having the strongest correlation with overall exam scores. ESC scores showed a 20% increase from the beginning to the end of the course. Results support the hypothesized relationships among the variables tested and suggest the possible importance of a spatially-related curriculum.

Sheraton New Orleans Hotel • New Orleans, LA

David Blades Eileen van der Flier-Keller

Grounding Earth Science for Classrooms: The Effects of a Pre-ed Lab Section for Prospective Education Students on Achievement, Science Literacy and Attitude in an Introductory College Earth Systems Course P-658-1324-1323-1355

A special laboratory section of a college-level Earth Science course was designed to reflect pedagogical strategies advocated by the Faculty of Education at the same university. Students in this one laboratory section (n = 20) were compared for gains in science knowledge, attitude towards Earth science and appreciation of pedagogical approaches to their peers in the other four (n = 93), who experienced traditional instructional approaches. In spite of the worry among some of the pre-education students that they were having too much fun to be learning science, this study reveals that students in the pre-education laboratory treatment final marks averaged 5% higher than the overall course average, and their lab marks were on average 7% higher than the class average. In addition, results of the pre and post course surveys indicate that the Education students made statistically greater improvement than their peers in attitudes towards Earth Science and in the correction of Earth Science-related misconceptions, suggesting that instructional approaches are a key factor in how well students at the college level learn science concepts.

Alan Blakely Brian Fortney

Membership & Elections Committee-sponsored session: Mentor mentee nexus P-786-1698-1695-1725

At this session, all members who indicated on their NARST conference registration from that they would like to serve as a mentor or be a mentee are asked to attend. The goal of this session is to serve as a nexus where members may be matched and then consider ways to benefit from a nurturing, professional relationship (particularly at the conference, but extending beyond if desired).

Margaret Blanchard Sherry Southerland

No silver bullet: Making sense of teacher change following an inquiry-based research experience for teachers. P-513-932-931-965

It is argued that teachers must experience inquiry to be able to translate it to their classrooms. One particularly promising form of professional development allows teachers to have their own experiences with scientific inquiry, an example being NSF's research experiences for teachers (RETs). As intuitively pleasing as such programs are, scant empirical evidence documents the effectiveness of these programs. For this study, four secondary science teachers were followed back to their classrooms following a five-week, marine ecology RET, asking the following questions: How do teachers' conceptions and enactment of classroom inquiry change after the program?; What accounts for these differences?; and What do these findings imply for future RETs? Findings indicate that teachers who had a sophisticated theoretical lens to understand teaching and learning were far more apt to use classroom-based inquiry throughout their teaching. Teachers with less sophisticated understandings upon entering the program were apt to cite contextual constraints as barriers to implementation of inquiry. This research suggests that experiences for teachers may be more effective if the participants are 'primed' to learn from them, and that professional developers should consider pre-program work to allow teachers to explore, reflect upon, and revise their own conceptions of teaching and learning.

Karen Bledsoe

How Do Engineering Students Develop and Reason With Concepts of Electricity Within a Project-Based Course? P-488-1508-1507-1538

This study investigated student conceptual change and reasoning with concepts of electricity within the context of a project-based lab for an introductory electrical engineering course. While a large body of literature exists on the effects of task-based learning, the majority of these studies measure before-and after differences. The purpose of this study was to observe changes in student concepts during a task-based course, and to observe how the strength of knowledge students bring to the task affects their ability to perform. Seven undergraduate students enrolled in the course were selected as case studies. Four demonstrated low prior knowledge, as measured on a written survey, while three demonstrated high prior knowledge. The students were interviewed near the beginning and at the end of the course to uncover their knowledge of the concepts of electricity, current, voltage, and resistance. Each student was observed and videotaped working in lab at least three times during the term, and their graded lab packets were collected. All students gained knowledge of electrical concepts during the term, though students with low prior knowledge tended to have more resistant misconceptions. Student reasoning and problem-solving in lab varied, but not always accordance with levels of prior knowledge. Student reasoning ability and study skills were strong influences on student performance, including the ability to successfully complete the tasks and to grasp the concepts that the tasks were intended to teach.

Jason Blonstein Catherine Milne

Confidence in Questions: Making Pedagogical Tensions Explicit through Professional Education in Science Courses

P-356-848-847-882

Our goal for professional education at the course level is consistent with the program model of professional education. We aim to foster reflective practice in the acquisition of content and pedagogical knowledge, skills, and dispositions that lead to active learning environments and the building of caring and supportive classroom environments functioning in a social and cultural milieu. Particular to science education, we used the methodology of scientific inquiry as a nexus of science content and pedagogy. Using phenomenography, our research examined the learning experiences of our students as they developed an inquiry-based urban science unit plan. Somewhat unexpectedly, a set of paradoxical tensions were observed in the products and behavior of our students as they worked on developing their plans, including the tension between pedagogy and content, between focusing first on the enduring understandings of instruction rather than the beginning of instruction, and between the isolated and socially embedded classroom. Making such tensions manifest broadens the resources and schemas available to these beginning teachers and helps them expand their options for action as teachers to resolve some of these tensions.

Ron Blonder

Harmful Results of Smoking Cigarettes and Water-pipes: A Science - Chemistry Laboratory for All Q-105-662-661-696

An experiment is described that examines smoking both cigarette and water pipe (narghile), from a scientific point of view. This experiment was aimed at providing the students with wide scientific knowledge about smoking and helping them understand the dangers associated with smoking cigarettes and narghile. It was found that the participants (adolescents, 14-16 years old) learned much new information about the dangers of smoking. Furthermore, the experiment also greatly influenced their attitude towards smoking cigarettes and narghile. In this article I describe the experiment, consisting of four stations, and indicate the chemistry knowledge and the smoking context' for each station. The original purpose of developing this experiment was to create a unique opportunity to link chemistry to a subject that is relevant to students and adolescents. In this study we describe this linkage and investigate the way these experiments influence the students' attitude towards smoking cigarettes and narghile. I developed these sets of educational experiments while serving as the director of the 'Belmonte Science Laboratory Center' at the Hebrew University in Jerusalem, Israel. This institute provides a unique setting for informal scientific education dedicated to high-school students.

William Hunter Provi Mayo

George BodnerRobert FergusonMaryKay OrgillTheoretical Frameworks for Research in Science EducationS-698-1420-1419-1451

The type of data a scientist collects in an experiment is influenced by his or her choice of instrumentation. For qualitative research studies, a theoretical framework plays a role analogous to the role of the instrument. A theoretical framework is a system of ideas, aims, goals, theories and assumptions about knowledge. It tells us how research should be carried out and how research should be reported, influencing what kind of qualitative experiments can be carried out and the type of data that result from these experiments. During this symposium, the purposes of theoretical frameworks will be discussed. Then, different theoretical frameworks will be examined in the context of science education research. The focus of this symposium is on the theoretical underpinnings of individual frameworks and their application to designing qualitative research in science education, not on specific research results.

Claus Bolte

How to promote scientific literacy different views from German experts P-563-1061-1060-1094

In the science education literature experts declare a wide consensus about the importance of a modern scientific literate society. But there is no consensus to find neither how to provide scientific literacy in science lessons nor what the major topics or dimensions of modern science education in the practice should be. But there is evidence that adult experts and young students have different opinions about the aims and the standards of a desirable science related education. With the help of the Curricular Delphi-Study in Chemistry I analyse fields of dissent and consensus in the opinions of 114 experts from different lobbies (students, teachers, educators, scientists). Knowledge about this helps to develop curricula or to plan lessons for science classes which fit better to the expectations of the adults as well as to the educational interest of the individual students, which - form a constructivist and general education view at least have to educate themselves self-determined.

Emily BordaDonald BurgessCharlotte PlogNatalia DeKalbMorgan LuceConcept Mapping as a Learning and Assessment Tool for the Nature of ScienceP-315-544-543-580

We describe a study in which concept mapping was investigated as a tool for facilitating learning of nature of science (NOS) concepts as well as for assessing students understanding of these concepts. Students in one section of a science methods course for preservice elementary teachers used concept maps to facilitate NOS discussions. Gains in responses to the Views of the Nature Of Science (VNOS) questionnaire for students in this section were compared with gains for a concurrent section in which concept mapping was not used. No statistically significant differences in gains were observed. However, concept maps from the treatment group revealed more dramatic changes in NOS understandings than did responses to the VNOS. Our results suggest that although concept mapping is not necessarily more or less effective than discussion as a learning tool for NOS, it may be a powerful tool for use in assessing students ideas about NOS. In this presentation, the authors will discuss the findings of this study and participants will learn how concept maps were employed and analyzed as an NOS assessment tool in conjunction with the VNOS.

Emily BordaMorgan LuceCharlotte PlogNatalia DeKalb

The effects of experience and context on discourse in an inquiry-based science content course Q-315-1370-1369-1401

We investigated the discourse of 14 preservice elementary teachers in the third course of a 3-course inquiry based science content series. We compared the discourse of students who had not taken the previous two courses (novices) with those who had (veterans). We also compared the students discourse across different contexts (tasks and instructor interaction) of three videotaped episodes. We found that most of the discourse was either procedural in nature or fell into categories related to Toulmin s argumentation pattern (TAP). When the discourse of novice and veteran students were compared, it was found that most elements of argumentation were used more frequently by veterans than by novices. This pattern was more striking with the higher-order elements of argumentation such as justification and rebuttal. Examination of the patterns of discourse across contexts revealed justification seemed more important in episodes of higher cognitive dissonance. Overall, however, claims were not often linked to justificiation and rebuttal was rarely used, suggesting important discourse patterns should be more explicitly taught in order to become fruitful for students learning.

Galit Botzer Michal Yerushalmy

Learning about motion graphs in a computerized environment through bodily activities *P-377-666-665-700*

This paper presents a part of research project, which is aimed to explore how bodily activities and formal knowledge interact in understanding motion. We examined how high-school students interpreted motion graphs which represented hand made motion. We used the MoveOn computerized environment, in which the mouse functioned as a motion detector and hence served as an available tool for exploring physical motion. Based on expanding research in embodied cognition, we analyzed the students gestures and language , and probed cognitive processes, involved in conceptualization of motion. The findings show that the students communicated through gestures and shared between themselves visual information, embedded in the graphs. They elaborated mathematics and physics concepts to interpret motion graphs and constructed personal meaning to the graphs, by referring to their own hand motion. This suggests that the setting we created has affordances to support the elaboration of formal conceptualization of motion and competency of understanding graphs.

Saouma BouJaoude Hayat Hokayyem

College Students Perceptions of the Theory of Evolution P-243-402-401-438

Although a well corroborated scientific theory, the theory of evolution has continued to cause dilemmas for some individuals who have not easily been able to accommodate the concepts of this theory within their cognitive culture. The reason lies in the overlap of some ideas that the theory advocates with other social, epistemological, and religious beliefs. This study describes how eleven college biology students who completed a course on the theory evolution perceive the relationship among their epistemological beliefs about science, their beliefs about religion, and their perception of nature and causality and their position regarding the theory of evolution. It also compares the different positions of the students to that of the course instructor. Questionnaires and semi-structured interviews were used to collect data. Qualitative methods were used to analyze the data and identify the various positions of the students and course instructor. The students positions ranged from complete acceptance to complete rejection of the theory of evolution. The results suggest that students personal beliefs should not be dismissed or underestimated when teaching the theory of evolution.

Saouma BouJaoude Justin Dillon

University science educators: Are we learning from each others experiences? P-784-1689-1686-1716

This seminar will examine professional development of science educators from a variety of perspectives. BouJaoude and Dillon will present the preliminary results of a survey of the readership of science education journals worldwide that aimed to determine the extent to which science educators learn from the experiences of international colleagues. Fraser-Abder will present a global perspective on professional development activities that provide a forum through which teachers can hone their skills, develop, support, and begin to address the specifications of working with their schools . Dillon s contribution will focus on the variation across Europe in terms of science professional development while Hofstein and Mamlok-Naaman will discuss three models of professional development used with Israeli science teachers. Finally, Abd-El-Khalick will focus on professional development for Egyptian teachers by describing two realizations of the Professional growth through engagement model used in large and small scale educational reform projects in Egypt

G. Michael Bowen Anthony Bartley

Making sense of lab reports: A detailed study of providing feedback on student reports on inquiry activities P-643-1512-1511-1542

Student teachers participated in two formative assessment activities where they were 'reviewing' a high school student inquiry report submitted to an on-line journal for publication. The goal of the student teacher reviewers was to provide detailed feedback on what changes needed to be made by the authors to make the reports as well argued/presented as possible without needing to re-do any of the research. Written reviews, interviews conducted after conducting a review, and 2h-videotaped 'think out loud' live reviews were analyzed for strategies and approaches used by the student teacher reviewers in providing the formative feedback. Implications of their practices, which included difficulties providing appropriate feedback on strength of claims which could be drawn in the reports and with the use of inscriptions, for student teacher preparation for engaging in formative assessment in high school science classes and laboratories are discussed.

Cathy Box Jennifer Wilhelm

One Teacher s Voice as She Enacts Project-Based Instruction With Middle School Students for the First Time

P-397-698-697-732

The Benchmarks for Science Literacy and the National Science Education Standards recommend that by the end of their middle school years, students should understand moon phases. However, alternative conceptions students hold may impede learning and pose an instructional challenge. The purpose of this paper was to chronicle how the collaborative efforts of forty-five 7th grade students, a teacher, a university science education professor and an online community of students worked together to help students learn about the moon and overcome alternative conceptions through a project-based moon unit. Students were immersed in a learning experience that gave them the opportunity to think and act like scientists. They asked questions, made observations and predictions, collaborated with others, used technology, developed models, made connections between evidence and explanations and communicated results. This research paper reports the effectiveness of the unit and reflects on the teachers professional development and areas of instruction that need strengthening. A mixed method design was implemented that included analysis of journals, online essays, pre- and post-surveys and formative assessment probes. Results showed that students made significant gains in learning about the moon and were able to overcome alternative conceptions experiencing a project-based moon unit.

Leah Bricker Philip Bell

Argumentation in science class, on the playground, and during debate club: Studying issues of learning, transfer, and adaptive expertise. Q-535-1467-1466-1497

Argumentation is a core epistemic practice in science yet largely absent from the practices in which young people engage during school science. In high school debate, young debaters are taught a specific, stylized form of argumentation to use in order to craft and disseminate their points about a given resolution and evaluate and refute the points of their opponents. In this study, we sought to better understand issues of learning and transfer associated with argumentation as youth engage in activities across the settings of their lives. Also, we sought to understand the relationship between the debate style of argumentation and the style of argumentation scientists employ in facets of their work. Lastly, we sought to highlight the benefits of studying young people's out-of-school talk and action when contemplating the design of school learning environments. Analytic tools used and the findings and implications those tools enabled are discussed.

Nancy Brickhouse,Angelo CollinsCharlene CzerniakNorman LedermanMichael KamenJames Shymansky

Into the Fire: Current Issues of Publishing Science Education Research S-768-1654-1651-1681

This symposium sponsored by the NARST Publications Advisory Committee will focus on current and controversial issues in publishing science education research. Participants include past and present editors of a spectrum of leading research journals in science education. The journals represent a range of research, including qualitative and quantitative, and use various publishing formats, including electronic. Editors from the following journals will give their perspectives: Science Education, Journal of Research in Science Teaching, Journal of Science Teacher Education, School Science and Mathematics Education, International Journal of Science and Mathematics Education, Cultural Studies of Science Education, and Electronic Journal of Elementary Science. During this open format session each editor will have opportunity to give her or her views on publishing in the editor's particular journal. Many of the issues will include those raised by NARST Past President, Jim Shymansky, in his 2006 NARST conference Presidential Address (See the E-NARST News July 06 issue for a copy of his speech). Examples of issues include style of publication, length of articles, publishing supplemental materials, electronic publishing, and others. There will be time for questions from the audience.

Sherri Brown Christy Rich

Effects of Collaborative Urban Elementary School Teaching Experiences on Fellows Beliefs, Attitudes, and Self-Efficacy and Elementary Teachers Content Knowledge P-338-580-579-616

To increase mathematical and scientific literacy, mathematics and science national standards explicitly advocate various collaborations among all interested vested parties. This study reports outcomes of an immersion project of post-secondary mathematics and science students (i.e., fellows) within public Title 1 elementary schools. Twelve fellows (5 mathematics; 7 science) completed pre/post selected Teacher Pedagogical Philosophy Interview questions, a pre/post Science/Math Teaching Efficacy Belief Survey, and 9 months of weekly journal reflections. These twelve fellows, along with their collaborating teachers (7 science; 8 mathematics), completed a pre/post mathematics or science content test. Survey results indicate that collaborative experiences had a significant impact on fellows personal science (math) teaching efficacy. An additional positive finding was that twelve of the fifteen teachers increased their content scores after the year-long experience. Specifically from the initial content analysis, science teachers gained content knowledge (+12.3%) after the summer workshop intervention. An even greater percentage gain (+16.8%) was discovered from the science teachers after the year-long collaboration with the scientist. Mathematics teachers had an average gain of 7% at the end of the year. The fellows average gains were smaller than their respective teachers for both science (+9.0%) and mathematics (+3%).

Bryan Brown Kihyun Ryoo Jamie Rodriguez

Speaking Towards Understanding: Learning to Be Literate Speakers and Writers of Science P-367-638-637-674

The language practices in science classrooms are often complicated and can limit minority students' access to science learning. This study examines the impact of an instructional approach that emphasizes teaching science by separating scientific concept and scientific language to improve students' conceptual understandings and associated language. We randomly assigned 49 5th-grade students into two groups (experimental and control) and taught them a web-based science lesson on photosynthesis using our experimental approach. We use a mixed methodology by using statistical tests to compare student learning supported by content analysis of students writing and an analysis of post instruction interviews. The results of the post-test revealed that students in the experimental group showed a better conceptual understanding of photosynthesis by significantly outperforming those in the control group. In addition, students taught using the experimental method demonstrated an improved ability to write using scientific language as well as an improved ability to use scientific discourse. The results of this study have implications for how science educators prepare teachers to teach a diverse student population.

Bryan Brown	Jhumki Basu	Meena Balgopal	Vicente Handa	
Joi Merritt	Nonye Alozie			
Building Rigorous Science Education through Students and Teachers Experiences				
S-558-1258-1257-1289	_	_		

The purpose of this session is to present the research of the Ethics and Equity Committee Scholarship Awardees. In particular, this symposium will disseminate information concerning the delivery of equity education including appropriate discourses, strategies, and resources in science education. The questions which tie the five panelists together are: (1) What funds of knowledge do youth bring to learning science? How do students express their ideas, experiences and funds of knowledge in their science talk and science writing? (2) How might curriculum be designed and adapted in ways that foster deep connections between the canon of science and the lives of youth? and (3) What tensions emerge in teachers practices as they work to craft rigorous science education that builds upon students funds of knowledge? Equity is a political issue that depends upon the landscape, desire, and languages of individual entities and the language that is used to describe it and the meaning of diversity. Understanding it will help prepare educators to evaluate and help change the landscape of science education. All of the presentations paint a better picture of the landscape of current multicultural science education.

Maja Brückmann

Reinders Duit

Investigating content structures provided in video-documented science instruction *P-140-754-753-788*

Consistency and coherence of content presented have proven key prerequisites for efficient science instruction. Clearly it is a necessary precondition for efficient teaching and learning that the content and its sequencing are sound from the science point of view. But it is also essential that different content units are intimately linked. 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 (e.g. on the force concept). 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.

Lynn Bryan Shanna Daly Kelly Hutchinson David Sederberg Eric Hagedorn Nicholas Giordano

A Design-Based Approach to the Professional Development of Teachers in Nanoscale Science P-645-1502-1501-1532

Incorporating emerging, interdisciplinary science such as nanoscale science into the classroom presents the challenge of designing new and innovative professional development for teachers of science. This study reports on a design-based research approach to the creation and implementation of the NCLT-PD experience, involving both a summer institute and academic year follow-up activities. The goals the NCLT-PD are to: (a) provide grade 7-12 science teachers with an enhanced understanding of nanoscience; (b) introduce teachers to inquiry-based methods for teaching nanoscience; (c) provide teachers with a collection of suitable classroom activities; (d) assist teachers in developing nanoscience investigations for classroom use; and (e) enhance teachers' awareness of the connections between nanoscience and the traditional sciences. To reach these goals, the NCLT-PD drew upon a theoretical framework comprised of research findings in the following areas of scholarship: (a) standards and reform-based delivery models; (b) science teacher professional development; and (c) reflection in teacher education. Each stage of design, development, and field- testing was aimed at building and refining a sustained- contact PD experience that supports teachers in their development of professional knowledge (content knowledge, pedagogical knowledge) for infusing nanoscale science into their existing science curriculum. Implications for PD are presented.

Gayle BuckVicki Plano ClarkDiandra Leslie-PeleckyComparing and Exploring the Perceptions of Science Role Models for Adolescent GirlsP-471-868-867-902

A growing number of science education programs include goals on increasing the number of scientists from underrepresented populations. One common strategy for reaching this goal is to provide students from these populations with role models. While the current literature on role models for adolescent girls provides valuable insights into the value of using role models, it leaves out understandings into the cognitive process involved with girls identifying a person as a role model. The primary purpose of this feminist inquiry was to address this gap by exploring the perceptions of science role models as held by eighth-grade girls participating in a science outreach program. The secondary purpose was to compare the girls perceptions to those of women scientist role models in order to suggest what promotes effective relationships with science role models. In this presentation, we will present the understandings that emerged from this study and discuss the implications for developing high quality science education programs.

Gayle BuckMargaret Macintyre LattaJuliann KaftanProfessional Development on Formative Assessment in Heterogeneous Science ClassroomsQ-471-873-872-907

The purpose of this particular pragmatic action research study was to develop an understanding of the experience of being a science teacher that is seeking to improve learning in her heterogeneous science classroom through formative assessment and subsequently using that understanding to improve our practice preparing science teachers to plan and guide inquiry-based instruction for all children. To capture the essence of the experience, the process was guided by the question, How does a middle level science teacher from a heterogeneous classroom come to better understand and utilize formative assessment? Our paper will provide data to support the following findings and guide the subsequent discussions: 1) Understanding formative assessment involved confronting the validity of tacit pedagogical understandings of the teacher; 2) Professional development on formative assessment must include the students; 3) Understanding formative assessment involved questioning the need to develop a more reflexive classroom teacher and students. The findings from this study are useful for persons seeking to foster inquiry-based science instruction through teacher development.

Nermin Bulunuz Olga Jarrett

Understanding of earth and space science concepts: Strategies for concept building in elementary teacher preparation

P-578-1157-1156-1189

This research is concerned with preservice teacher understanding of six earth and space science concepts that are often taught in elementary school: the reason for seasons, phases of the moon, why the wind blows, the rock cycle, soil formation, and earthquakes. Specifically this study examines the effect of readings, hands-on learning stations, and concept mapping in improving conceptual understanding. Undergraduates in two sections of a science methods course (N=52) completed an open-ended survey, giving explanations about the above concepts three times: as a pretest and twice as posttests after various instructional interventions. The answers, scored with a three point rubric, indicated that the preservice teachers initially had many misconceptions (alternative conceptions). A two way ANOVA with repeated measures (pretest/ posttest) found that answers became more accurate after learning about the concepts through reading or engaging in hands-on activities but that hands-on activities were more effective than reading in building conceptual understanding. Concept mapping had an additive effect in building understanding, as evident on the second posttest. The findings suggest useful strategies for university science instructors to use in clarifying science concepts while modeling activities teachers can use in their own classrooms.

Christopher Burke Richard Moyer

What is an epistemology? Examining proximal vs. Distal understandings of the Nature of Science in Preservice teachers science autobiographies. P-677-1363-1362-1394

This paper examines pre-service elementary teachers understanding of the nature of science and how it is developed in an introduction to science course. In this course, the students complete a science autobiography where they are asked to identify key experiences that shaped their definition of science. Based on these experiences students are asked to articulate their personal definition and explain the relationship between their experiences and their definition. In addition students are required to conduct an independent experiment about a topic of personal interest. As part of the final report on the experiment students are asked to reflect on the process and how the science processes that they used helped to shape what they learned. How they understand what epistemologies are and their own epistemological development are important factors in how they understand the nature of science. In addition the way they make sense of the nature of science (distal understandings) are important in terms of how they deal with the nature of science in their own learning and teaching.

Carol Butler Freeman Steven Semken Anton Lawson Michael Oehrtman Jamie Jensen Christopher Schaufele

How Old is the Earth: An Exploration of Geologic Time through Place-Based Inquiry P-540-997-996-1030

Geologic time is fundamental to the study of the Earth and life sciences, but it is an abstract concept difficult to teach using a lecture-based approach. Place-based inquiry teaching methods were applied to the problem. Two 2- part inquiry lessons on geologic time based on Arizona rocks and landscapes were designed and administered to 52 in-service middle- and high-school math and science teachers enrolled in a master s level course. The teachers' content knowledge before and after the lessons was assessed using the Geoscience Content Inventory (GCI). Analyzing the GCI scores with a non- directional dependent samples t-test, we reject the null hypothesis of no mean differences, t(49) = 5.35, p < 0.01. We conclude that there is a significant difference in the teachers geological time content knowledge before the inquiry lessons (Mean = 11.66, SD = 2.92) and after the inquiry lessons (Mean = 9.74, SD = 3.57). These results demonstrate that inquiry techniques facilitate student learning about geologic time. The teachers who participated in the class also found these lessons to be enjoyable and interesting, and they ranked these lessons among their favorites for the course.

Coral Campbell Gail Chitleborough Peter Hubber Russell Tytler

Educating for the Future: Technological Advantage? P-767-1651-1648-1678

Educating students for the future involves providing them with skills to cope with technological change. Schools and teachers have been adapting their practices in mathematics and science to incorporate information and communication technology (ICT) as a routine aspect of learning. However, recent research indicates that not all students have equal access to the technologies they need. A number of reasons are investigated: the location of the schools (regional and rural settings), the capabilities of the teachers and access by staff and students to high quality resource. This paper presents the findings of this research.

Bilge Can Esin Pekmez

A Study of Proespective Teachers' Beliefs About the Nature of Science and Self-Efficacy P-562-1070-1069-1103

The studies on the nature of science have caused to be paid more attention to this field in the area of science education. It is thought that, in order to acquire this understanding to students, teachers are the main factors. Therefore, in this study, preservice teachers' understanding of the nature of science and how they reflect this on their teaching profession is taken into consideration. During the literature review, it has been found that there were serious problems in learning and teaching the nature of science (NOS). This study aims to determine how the preservice teachers will apply their views about NOS in teaching science. In this research, in order to determine student teachers' beliefs about NOS and self efficacy in science teaching a quantitative study has been done with 146 students in two different universities. After analyzing the results of this pre-study, 7 preservice teachers were, randomly selected by using stratified sampling method, interview in each group. According to the findings, it was seen that little attention was being paid to the NOS by prospective teachers. On the other hand, there is a significant difference between the groups in two universities regarding their philosophy of teaching science.Key Words: Science education, Science learning and teaching, Nature of Science, Self-efficacy.

Brenda CapobiancoTom McConnellLauren SchellenbergerMichelle PriddyPreparing stewards of the discipline through collaborative action researchQ-448-803-802-837Michelle Priddy

The role of teacher action research is well documented in pre-service, in-service, and independent teacher professional development initiatives. However, little is know about the instrumental role teacher action research plays in the professional development of teacher educators. This study examines the use of collaborative teacher action research in assisting three prospective science teacher educators professional development and growth. Participants employ qualitative methods, such as interviewing, reflective e-journaling, formative assessments, and classroom observations, as a means of assessing the impact of their instructional approaches. Data sources include the participants final action research papers, reflective journal entries, the instructor s field notes from class discussions, and additional supporting documents. Data were analyzed using cross-case document analysis and narrative inquiry. First- and second-order action research results reveal the complex ways prospective science teacher educators gained new pedagogical knowledge, professional understanding, and ability to reflect critically on how to better prepare pre-service science teachers.

Loran Carleton Gerald Krockover

Investigating Undergraduate Atmospheric Science Students Ideas about the Nature of Science Q-92-156-155-192

Ideas about the nature of science (NOS) held by undergraduate atmospheric science students were explored using the Views on the Nature of Science (VNOS) Instrument, Version C. VNOS responses were analyzed to reveal common ideas about NOS held by the subjects and these ideas were grouped into four categories: ideas about the definition of science, ideas about scientific knowledge, ideas about the role of evidence in science, and ideas about the scientific enterprise. Common ideas held by these undergraduate students in each category are discussed. Additionally, correlations among previous college coursework and the prevalence of ideas about NOS are discussed.

Heidi Carlone Sue Kimmel Christina Tschida

Science Education, High-Stakes Accountability, and a Globalized Rural Economy: An Ethnography of a Math, Science, and Technology Elementary School P-656-1588-1587-1617

Historically, science education research has viewed the science classroom as a bounded entity. However, we argue for viewing it as what Jan Nespor (1997, Tangled up in school: Politics, space, bodies, and signs in the educational process, Mahwah, NJ: Erlbaum) calls a knot in a web of practices that stretch into complex systems beginning and ending outside the [classroom] (p. xiii). In this ethnographic study, we explore how meanings of science within a math, science, and technology elementary school in a rural mill town in the Southeast United States were negotiated across various networks of practice. We discuss the following relevant networks of practice: (1) economic realities brought on by globalization of manufacturing; (2) sociohistorical meanings of a good elementary education; and (3) sociohistorical meanings of a good science took on a variety of meanings, including: science as gateway to a better, more prosperous economic future, but also a threat to the stabilized, tradition-bound nature of life in the county; science as a conduit to a richer, more innovative elementary curriculum, but also a challenge to historically enduring meanings of a good elementary, back-to-basics curriculum; and science as a conduit for equity versus science as a subject for the elite.

Kevin Carr

Conflicting Discourses: Preservice Science Teacher Action Research as a Scaffold for Negotiating Student Teaching

Q-38-301-300-337

This paper presents two case studies illustrating how action research projects helped pre-service high school biology teachers negotiate, resist, and interpret conflicting discourses encountered while student teaching. In each case the student teachers planned to use representing-to-learn strategies, taught in their university methods courses, as part of a required curriculum work sample. Each student teacher was positioned among the conflicting discourses of the university, mentor teacher, and self. One student-teacher proposed teaching cell mitosis through kinesthetic activity, a strategy supported by her university methods instructor but opposed by her mentor teacher and other placement site staff. The second student teacher wished to implement a Flash animation project to teach protein synthesis, but encountered barriers in the form of lack of equipment and her own inexperience using technology. Both student-teachers carried out action research projects during their practica, supporting for each in different ways the negotiation of powerful and conflicting discourses, enabling the successful implementation of teaching strategies taught in their university methods courses.

Sarah Carrier

The role of gender in environmental education in the schoolyard P-603-1448-1447-1479

The importance of environmental education has become more widely recognized because many problems affecting our daily lives; including energy conservation, limited natural resources, ecosystem management, air and water quality, and global warming; require informed decisions about possible solutions. It is critical that environmental education efforts include children, because they will ultimately be responsible for making decisions about environmental issues and problems. The scientists, voters, and adults of the future will need to understand and take action on environmental issues. The current study focused on the role of gender and is part of a larger study that examined the effects of an outdoor, schoolyard environmental education program on 4th and 5th-grade students' environmental knowledge, attitudes, behaviors, and comfort levels in the outdoors. One unique characteristic of this study was that the location for the treatment group outdoor activities was the schoolyard as opposed to a field trip to a nature center or a residential camp. Significant gender effects were found in the combined treatment and control group samples for environmental attitudes. Triangulation of quantitative and qualitative data are included in the study.

Jennifer Cartier

A Longitudinal Study Teachers' Enactment of Instructional Materials: How Professional Development, Institutional Context, and Identity Interact to Shape the Enacted Curriculum P-147-1054-1053-1087

In response to the NSES call for engaging students in key aspects of scientific practices, and to increasing pressure from policies like NCLB, school districts across the U.S. are rewriting curriculum and adopting new 'reform-based' instructional materials. At the elementary level many such materials are packaged as kits that place strong emphasis on exploratory experiences for students. In this study, we sought to determine whether a two-year professional development intervention that focused on critique of instructional materials could impact how or whether teachers used those materials to enact inquiry practices (e.g. data representation, prediction, explanation) in their classrooms. We found that two of three focus teachers increased their use of inquiry-congruent instructional strategies throughout the study. However, these teachers enacted the curriculum in qualitatively different ways that were related to their institutional contexts and professional identities. We conclude that professional development focused on critically enacting instructional materials might be most effective for promoting scientific practices in elementary classrooms when the teachers involved have a strong sense of professional agency.

Jeffrey Carver William Hunter

Portfolio Assessment in Science Education P-520-949-948-982

Grading practices in science education have essentially followed two lines of thinking. The first approach is based on a total points system. A teacher will assign various point values to assignments and the student grade will be determined by calculating the amount correct out of the total possible points. The second approach utilizes a weighted average system where various assignments are grouped together. A percentage is determined for each category. Then each category is weighted with a percentage. The results of the calculations are then added together and represent a percentage for the course grade. This proposal involves a research project in which portfolio assessment was applied in a preparatory chemistry class. The portfolio assessment ties a standards-based approach to teaching together with authentic assessment in the form of a portfolio. This paper describes the development of the standards, the portfolio design and a new model to determine a student s science grade that puts more onus of control on the student and is representative of the students understanding of the concepts of science. This method combines a standards-based approach within a constructivist framework to allow for a grade that is representative of a student s overall ability in science.

Marie CashionLesley BalcomEssie LomMeg McCallumJoining an Extra School Science Program: Is there anyEffect on Classroom Science Experiences?P-517-1310-1309-1341

Almost all studies in informal education describe the age and school level of the children who are surveyed or observed. We could find none that looked at the kinds of students who choose to participate in such programs in terms of the learning ability, social situations, or socio- economic circumstances. Who are the kinds of students drawn to science programs in the elementary school and are these the same kinds of learners drawn to the programs in middle school? Could we create a program that would make it possible for a wider range of learners to develop successful understandings of science? We found that all kinds of learners were drawn to both programs with one thing in common an interest in science. In this first phase we are beginning to identify the kinds of learners who choose to participate and what they need to learn more effectively. As a consequence, they have had considerable influence on the direction and development of the programs.

Kefyn Catley Laura Novick

Digging deep: Exploring college students understanding of macroevolutionary time P-674-1382-1381-1413

Some ability to comprehend deep time is a prerequisite for understanding macroevolution. This study examines students understanding of deep time as it relates to the age of the Earth, the emergence of life, and five other significant historical events, including the appearance of a pre-modern human, Homo habilis. The subjects were 110 college students recruited from psychology, education, and biology classes at two universities. In order to investigate how accuracy varied as a function of biology background, students were assigned to stronger and weaker background groups based on the nature of their biology coursework. Of interest were the startlingly large time ranges provided for each question, ranging over several orders of magnitude (e.g., from 1000 to 20 billion years for how long ago most dinosaurs became extinct). These results suggest that many, perhaps most, students are without an effective conceptual framework to make sense of very large time frames. We describe a pedagogical strategy that uses a relative approach, presenting major evolutionary events as they unfolded, and advocate using a tool from professional practice to help students visualize events in time and space.

Janell CatlinFelicia MooreRESPECT: What Urban Middle School Science Students Really WantP-467-909-908-942

This paper focuses on an underlying issue between urban middle school science students and their science teachers. In an attempt to address issues of inequity in urban schools this study examines four students in an after school science program. Through this ethnographic study, the researcher suggests what urban middle school science students really want from their science teachers in order to become more productive, motivated students in their science classes. Interviews with both students and their science teachers, and field notes were employed in order to examine the relationships between teacher and student in both the classroom and the after school science program. This paper suggests that urban middle school science students view racism and respect equally.
Andy Cavagnetto

Brian Hand

Lori Norton-Meier

Pensri Bunsawansong

Teachers' Struggles with Embedding Argument Within Science Inquiry and the Promotion of Student Control and Student Voice in Setting the Question for Exploration P-226-553-552-589

This study was conducted to determine the effects of two student-centered approaches to setting the question for inquiry (whole class and small group). Whole class consisted of students setting a single question for inquiry, which the whole class would explore. Small group consisted of each student group setting a question, which only their group would explore resulting in numerous questions per class. A mixed method quasi-experimental design was utilized. Two grade-five teachers from a rural school district in Iowa participated, each teaching two sections of science. Results indicated instructional approach did not effect student achievement. Pedagogical skills of dialogical interaction and effective rather than efficient use of time were identified as key factors in teachers progression toward student-centered, teacher-managed instruction. Specifically, increased dialogical interaction in the forms of greater student voice, and increased cognitive demands placed on students via questioning and emphasizing science argument within student inquiry corresponded to positive gains in student achievement. Additionally, teacher s perception of student abilities was found to influence rofessional growth. These results suggest that more time should be spent on challenging teachers to align their pedagogy with how students learn rather than providing strategies and lesson plans for teachers to use.

Ayla Cetin Zubeyde Kirbulut

The Scale Development on Attitude and Motivation and Examining the Relationship between the Scales P-297-502-501-538

Research studies in science education show that science learning cannot be explained only by cognitive factors. Among the affective variables, attitude is an important one which influences one's construction of knowledge and action to something. Additionally, motivation is an internal state that arouses, directs, and sustains students' behavior. The purpose of this research was to construct a Likert type scales to measure students' attitudes and motivation toward chemistry as a school subject and examine how student related variables such as gender, mother and father education level, and number of books at home affected students' chemistry related attitudes. The item pools of the scales were first administered to 347 high school students and refined. The final scales consisting of 24 items for attitude scale and 23 items for motivation towards chemistry were found to be as .88 and .92, respectfully. The validity studies were conducted. Correlation between chemistry related attitudes and motivation towards chemistry was found to be as .87. It can be said that these scales toward chemistry will serve a useful scale to measure students' attitudes and motivation toward chemistry will serve a useful scale to measure students' attitudes and motivation toward chemistry.

Yaowares Chaiyen Naruemon Yutakom

Teaching and Learning About the Nature of Equilibrium: A Case Study from Thai 11-Grade Classroom P-731-1538-1537-1568

The purpose of this study is to promote teaching and learning about the nature of equilibrium which consists of two topics: reversible reaction and dynamic equilibrium. A constructivist-based learning unit related to the nature of equilibrium concept was developed. Then, the learning unit was implemented with the 11th grade classroom by a volunteer chemistry teacher from a school in Chanthaburi Province, Thailand. Using an interpretive methodology, the chemistry teacher was observed in every period and semi-structured interviewed at the end of the implementation of the learning unit. Students' interviews, field notes, classroom observations, and students' worksheets served as students' data sources for this study. Several techniques of data collection were employed for ensuring trustworthiness of the findings. The findings showed that the constructivist-based learning unit could help students to understand the nature of equilibrium concept. Additionally, the learning unit also helped the teacher to develop her teaching strategies for promoting constructivist-based perspectives especially in the nature of equilibrium concept. Implications from the findings are significant as chemistry teachers to continue to use constructivist-based perspectives for promoting students to understand the nature of equilibrium concept. Implications for promoting students to understand the nature of equilibrium concept. Implications for promoting students to understand the nature of equilibrium concept.

Joan Chambers

A critical examination of the production of instructional resources for the elementary environmental science classroom P 490 1545 1544 1575

P-499-1545-1544-1575

Environmental education is usually subsumed primarily within the subject of science. Consequently, environmental science instructional resources play a significant role in shaping student understanding and attitudes towards environmental responsibility and stewardship. As part of a larger research study, which includes a critical examination of the discourses, the language and images, of environmental science resources, this study centers on the qualitative analysis and interpretation of interviews conducted with the producers and/or writers of these resources. Research questions included: What perspectives on environment and environmental education do they hold? What do they perceive their role in resource production to be? As an organization, what do they hope to accomplish? An interpretive account of the views of three representatives from provincial government and two non-governmental organizations indicate these organizations view their role as necessary, fulfilling a need for instructional resources and teacher professional development. The interview data also indicates that corporations have a significant impact on resource production, particularly in terms of monetary sponsorship. This study raises questions about the ways in which the discourses of these agencies seek to influence and shape the enacted curriculum in the science classroom and raise awareness of the influence of corporate entities.

Audrey ChampagneReinders DuitJane KahleAnton LawsonNorman LedermanResearch in Science Education: How Well Does Our Research Build Upon, and is GuidedS-770-1658-1655-1685

The purpose of this session is to provide NARST members with an opportunity to build an understanding of issues and trends in science education research from a historical perspective. A panel of senior science education researchers, including past presidents of NARST, will tackle questions related to the past, present, and future of research in science education. Participants will provide perspectives on developments in theory and underlying assumptions, research methodology and findings, and progress (or lack thereof) in five research domains in science education, which will serve as case studies. Presentations will focus on exploring how research in these five domains builds (or fails to build) on existing research to form meaningfully connected and synergistic lines of inquiry.

Kim Charmatz

A Case Study of the Development of Environmental Action Projects from the Framework of Participatory Action Research within Two Middle School Classrooms P-480-1251-1250-1282

The purpose of this study was to explore the development of environmental action projects within a school community. Using the framework of participatory action research, a major underlying goal was to understand student and teacher empowerment through a socially critical environmental education perspective. The main research question was: How do participants make sense of a learning experience in which students design and carry out an environmental action project in their community? The study used a mixed methodological approach including both qualitative and quantitative analysis. Data included pre-post student surveys, pre-post scores on an environmental critical thinking and literacy instrument, observations, interviews, and student work. Findings indicated the importance of communication and cooperation in the classroom and school community; the development of tensions as a result of attempting to incorporate socially responsible projects into the accepted school curriculum and classroom (e.g. who decides what is socially responsible?); students reported environmental action and interdisciplinary content knowledge but did not show significant pre-post test differences on an environmental literacy instrument; students participated in a range of environmental actions related to the concept of empowerment; and teachers identified connections between the objectives of environmental action projects and established curriculum, although different teachers tended to view these connections differently. This proposed presentation will review in more detail the findings and implications of this study.

Catherine Chen Kathleen Schwille Nicole Wickler

Science Teachers Learning From Lesson Analysis: The Use of Videocases in Inservice Teacher Education P-396-1445-1444-1476

Studies of effective professional development programs show that inservice teacher education programs need to concentrate on the content and curriculum, while engaging teachers in sustained inquiries that support their content learning in the context of teaching. The Science Teachers Learning From Lesson Analysis (STeLLA) Project responds to these needs in inservice teacher education. Funded by NSF and the California Science Project, the STeLLA project targets 4th, 5th, and 6th grade inservice science teachers in a year-long, video-based PD program. The project is based on a conceptual framework that focuses teachers attention on the content storyline and student thinking in science lessons. The purpose of this paper is to demonstrate how such a conceptual framework, along with structured video analysis tasks, is being used in inservice teacher education. The paper provides a description of the professional development program and research design, as well as specific examples of analytical tasks to study the effects on teachers science content knowledge, their abilities to analyze lessons, changes in their science teaching practice, and on their students science content learning.

Peilan Chen Yuhtsuen Tzeng

Impact of Reading and Developmental Factors on Children's Questioning Representation P-166-618-617-654

Questioning has its pivotal position in exploring knowledge. The competency to ask question is mediated by several factors. In this study, we analyze 2nd, 4th, and 6th graders questioning of inscriptions. Children's grade, daily reading time, prior knowledge, graphics comprehension and attitude about graphics are collected to investigate their relationship with numbers of questions they generated after viewing graphics of a toaster and a snail. The results show children's grade and daily reading time are crucial for children's questioning representation, but different patterns emerge on different contents of graphics. Our finding partially supports knowledge clash hypothesis and points to some cognitive mechanisms developed between 4th graders and 6th graders are worth further investigation.

Shih-Wen Chen Wen-Gin Yang

Exploring Students' Semantic Comprehension in the Hyponymy and the Meronymy of Science Concepts P-319-954-953-987

The purpose of this study was to explore the students' semantic comprehension in the hyponymy and the meronymy of science concepts in science textbooks. The statements in science textbooks usually involve the process of concepts classification when organizing the science concepts. Hyponymy means 'a kind of' relation, while meronymy means the 'a part of' relation. A text of 'Matter and Atom' was extracted from the science textbooks of the secondary school. 368 8th to 11th grade students were asked to answer the instrument which called 'Semantic Test of Matter and Atom' after reading the treatment text. The results showed a few students confused with the relation of hyponymy or meronymy. Senior students comprehended the relations of concepts more clearly than junior students did. However, students showed the diversity of their semantic comprehension when the statements were restated with the opposite semantic relations (hyponymy vs. meronymy) and with different forms (e.g. X is a part/kind of Y and A part/kind of Y is X). The result indicated not only the semantic relations but also the statement forms could affect students' semantic comprehension in the hyponymy and the meronymy of science concepts in science textbooks.

Jun-Yi Chen Huey-Por Chang

Chorng-Jee Guo

Wen-Yu Chang

Put inquiry teaching into practice: A feasible model of infused inquiry teaching P-584-1110-1109-1143

The purpose of this three-year research was to develop a longitudinal and collaborative project of professional development in assisting science teachers to understand and implement inquiry teaching. A 5P model of professional development was adopted to provide science teachers with the opportunities to engage in inquiry activities, construct the experience of inquiry teaching as well as develop the strategies of inquiry teaching. Nine junior high school teachers were invited to participate in this research. Meetings were held for teachers to discuss their practices of inquiry teaching. Then, teachers were assisted to develop the lesson plans of inquiry teaching. Teachers also considered and overcame some restrictions which were derived from educational institutions and inadequate individuals as well as students' deficient competency. Data were collected by a questionnaire, interviews, observations and artifacts. Through exploring, designing and implementing inquiry teaching, a model which was evaluated as appropriate and would be implemented in actual science classrooms was called infused inquiry teaching (IIT). The IIT model was a successful case which could be infused into the formal curriculum in Taiwan. This paper mainly reported the characteristics and content of the IIT model.

Tzu ChengHuey ChangA Study in History of Science Teaching by AIH (Anchored in History Instruction) InstructionP-187-310-309-346

Based on the video idea by Becker(2000) and the experiment idea by Monk and Osborne(1997), we constructed the AIH(Anchored in History)instruction which integrated the video about history of science(HOS)and the inquiry experiment into teaching. The purpose of this study was used the AIH instruction to investigate the influence of preservice teachers' science concepts, views of nature of science(HOS)and teaching beliefs. We taught 27 preservice teachers a unit about Galileo and heliocentric theory of the AIH instruction in eight weeks, and used two questionnaires to evaluate the changes of the participants before and after the teaching. Results showed significant different and improvements in participants' science concepts and some differences in their views of NOS view. However, the changes of teaching beliefs were not significant. We concluded that the unit of the AIH instruction indeed has its function in HOS education, but also faces the same situation that participants' teaching beliefs are the most difficult to change.

Meng-Fei Cheng David Brown

Conceptual Resources in Self-developed Explanatory models P-365-1461-1460-1492

This study explores two questions: what are the conceptual resources students use, and in what ways do they use them, to construct explanatory models? and when they fail to do so, what are the obstacles preventing them from constructing a useful explanatory model? Our findings indicate that connecting intuitive knowledge and verbal symbolic knowledge is the only way for students to construct coherent and sophisticated explanatory models. If students rely only on intuitive knowledge, they may construct a tentative and non-sophisticated explanatory model; if students reply only on verbal symbolic knowledge at an abstract level without connection with their intuition, they may not have ability to construct an explanatory model. This research shows that instruction should help students to connect their verbal symbolic knowledge and intuition to construct students own explanatory model to make sense of abstract scientific knowledge.

Man Wai Cheng Siu Ling Wong Benny Yung

Students' understanding of scientific models in different contexts: The impact of teaching on the nature of models

P-730-1532-1531-1562

The study investigates students' understanding of the nature of models before and after a teaching session. Pre/Post-test analysis showed that students have gained the declarative knowledge of models and understood that modeling process can highlight, simplify, or ignore certain elements of the entity being modeled, which implies that students have developed their thinking beyond the first level of model understanding (Grosslight et al, 1991). Post-lesson interviews were conducted to investigate if students were able to apply their knowledge about models to the understanding of specific scientific models in different contexts, namely, (i) Bohr' orbit model and quantum mechanic model of atom and (ii) electron-sea model and Daltonian atomic model of a piece of metal. If models serve descriptive, explanatory and predictive functions (Treagust et al., 2004), the data showed that students' ability to conceptualize these functions of models can be contextual. On the one hand, they were able to comprehend and evaluate various models of a piece of metal, and were able to see the explanatory/predictive role of the electron-sea model. On the other hand, they could also confuse various atomic models and focused on the descriptive functions of orbital model. Suggestions on the teaching of scientific models are provided.

Pauline Chinn

Indigenous Knowledge Contributions to EE P-772-1662-1659-1689

This invited symposium hosted by the new environmental education strand (14) will consider the unique contexts that environmental education may provide for science education and its associated research. The discussion will be prompted by brief presentations from invited panelists (above) that will examine the historical, present and future condition of environmental education activities at NARST. Participants will engage in facilitated discussions aimed at building capacity within the new strand while working towards a shared vision for future research dissemination activities hosted by the environmental education strand.

Guo-Li Chiou O. Roger Anderson

Mental models of heat transfer Q-294-1381-1380-1412

This study addresses the issue of how people manipulate their mental models to generate predictions and explanations of physical phenomena using a new approach integrating perspectives of conceptual development (Vosniadou and Brewer, 1994) and mechanistic mental models (de Kleer and Brown, 1983). To test the effectiveness of this new approach, semi-structured interviews with two Taiwanese elementary school teachers were conducted to probe their domain-specific knowledge bases and to assess how they mobilized mental models of heat transfer when presented with a problem situation. The participants drawings were used as evidence of their visual representations of mental models and their verbal responses to the interview questions were transcribed and analyzed to provide additional evidence of language-based representations. The results indicated that the participants' domain-specific knowledge, particularly those represented in forms of production rules and mental images, appeared to influence the construction and manipulation of mental models on the basis of their familiarity with the presented situations. In addition, mental conflicts between existing knowledge and initial predictions appeared to be triggered in the process of manipulating mental models, which then led to peripheral conceptual changes.

Houn-Lin Chiu Chia-Ju Liu Chia-Chu Weng

What kinds of representation do female students prefer in their science learning? Q-420-1229-1228-1260

The purpose of the study was to investigate female students preference and perspectives of different kinds of representations in web-based instructions about the concepts of atoms and molecular bonding. Twenty-five 10th-grade students participated in this study. The results indicated that most female students prefer dynamic simulated representation because it closed to the true state. And most female students prefer pictorial representation than symbolic representation because pictorial representation is more concrete than symbolic representation. When they begin to work on an experiment, they would like to use non-interactive representation first, and after a while they liked to use interactive representation to understand the experiment better.

In-Young Cho

Carbon Cycle Learning Progressions for K-12 in Korea and the U.S. P-709-1485-1484-1515

This study is designed to compare Korean and the U.S. K-12 students carbon cycle learning progressions in environmental systems. Developing conceptual framework for the item analysis based on the students accounts of the phenomena as a unit of analysis. The analysis moved from micro-level to macro-level while extracting core issues from each setting and comparing the patterns identified. The specific categories of the analysis framework emerged as a theory-data examinations. All students groups in two countries had difficulty in connecting macroscopic observation of phenomena in environmental systems to the microscopic and large scale explanations of the processes in systems. U.S. students demonstrated reversed developmental tendency in their accounts of connecting macroscopic observation to microscopic matter transformation process while Korean students learning progression showed better understanding of molecular level accounts. Carbon cycling learning progression on a large scale suggested that Korean students tended to explain the hidden mechanisms of the processes in human and natural systems more unidirectionally with difficulties of identifying substances involved. However, Korean students tended to rely on authorities of information while U.S. students utilized media and personal experiences.

In-Young ChoGail RichmondCharles AndersonLittle Scientists Talk in Inquiry Science Classroom2-709-1481-1480-1511

This study examines the discursive practice of Science Talk for reform-oriented Science Inquiry teaching in three kindergarten science classrooms. Through examining discursive practices, roles of the students and teachers, and classroom cultural tools, this study highlights the patterns of teaching practices. Science Inquiry teaching was explained according to Observation-Patterns-Models/Theories model. Dialogic Science Talk model was developed for describing the patterns of Science Talk practices. Detailed, multi-level analyses were carried out on transcribed video recordings of classroom discourses. The empirical data set also included transcriptions of semi-structured and open-ended teaching interviews, pre-post observation interviews, and professional development meeting notes. The result shows unique differences in participating teachers purposes of science teaching and in the patterns of teaching practices of Science Inquiry and Science Talk, even though they discussed general instructional strategies in the professional development learning communities. When a teacher set curricular goal as conceptual understanding and enacted the purpose by inductive inquiry process from Observations to finding Patterns and to explaining Models which was facilitated by dialogic-enhanced science talk style, students actively participated and gained more autonomy of knowledge construction and utilized classroom cultural tools more generatively for the meaning negotiation processes.

Seung-Urn ChoeYumin AhnMiae LeeNa-Hae SungViews on Evolution and Creationism: The cases of theology and science undergraduates in KoreaQ-711-1612-1611-1641

The purposes of the study are (a) to compare viewpoints of undergraduate students majored in theology and science in Korea, which are related to the origin of universe and human being, (b) to portray their views of science, and (c) to look into diversity of view about the origin throughout lectures related to understanding of modern science to theology major undergraduates. 82 undergraduates in theology (pre-course, 44; post-course, 38) and 19 in science were participated in this questionnaire. The data revealed a group who exposed theistic evolution (46%) to be predominated, and no subject who support evolutionism in theology major. On the other hand, most respondents in science (education) major espoused evolutionism and no body assert extreme creationism. Also most creationists shared the insights that science is the instrument for describing the Creator s work, but most evolutionistic views of science are a science as logical and descriptive system of natural world. After taking course of understanding of modern science, the number of respondents in theology that support creationism decrease rapidly.

Hye-Eun ChuDavid TreagustA Chandrasegaran

Naïve Students' Conceptual Development and Beliefs: What Contributes to Student Success in a University Introductory Physics Course? P-295-498-497-534

This research was designed for naïve physics learners who were interested in majoring in science or engineering. In a semester-long quasi-experimental study, students were given open-ended pretests and posttests to analyse their conceptions relating to sound and wave motion. Semi-structured interviews were also conducted to elucidate how their conceptions developed from everyday conceptions to unclear scientific conceptions to scientific conceptions as well as their beliefs of physics. Despite efforts to enable these students to learn physics, the findings showed that only two of ten students developed acceptable physics conceptual development was related to their cognitive understanding and to epistemological beliefs of physics. Therefore, to facilitate naïve physics learners success in a general physics course, in addition to the acquisition of content knowledge, explicit emphasis needs to be placed on the nature of physics knowledge.

Dan Churach Tony Rickards

The Science Career Inventory (SCI): A new tool to access career choice motivational drivers in a sustainable minerals processing sector P-291-492-491-528

Sustainability and ecologically friendly industrial processing within the mineral resource sector is dependent upon skilled people using applied science to solve problems and add value to Australia's common wealth. The downturn in schools students enrolling in STEM (science, technology, engineering and mathematics) courses has caused a dearth of students choosing research careers in the minerals and energy sector and thus confronts Australia particularly and the world in general with an unsustainable shortfall of the scientists and researchers needed to solve increasingly difficult environmental problems. In order to acquire a better understanding of the motivating forces that induce university graduates with science and technical backgrounds to make a career choice in this area, the authors have developed a new investigative tool, the Science Career Inventory (SCI). The paper describes a study trialing the SCI and presents validation and reliability data for this new instrument. The Science Career Inventory aims to offer better insight into why scientific researchers choose their careers in the hope that educators can better attract new students into scientific disciplines. Though the initial studies are carried out within the energy and mineral resource sector, it is anticipated that other versions of the SCI could be used across the entire spectrum of scientific research careers.

Jacob Clark Blickenstaff

Implementing Reformed Science Curricula for Higher Education and Professional Development Settings P-288-481-480-517

One product of the North Cascades and Olympic Science Partnership is the development of new Earth and Life science curricula for both teacher preparation and teacher professional development. This related paper set will address the development, implementation, and outcomes of the process. In particular, this third paper of the set describes the implementation of the content courses in the various higher education settings and in the Summer Academy. Select video recordings will supplement written samples of the curriculum materials to illustrate how the materials work in practice.

Jacob Clark Blickenstaff Sally Holloway

Challenges and Successes in Transferring from Community College to a Science Teacher Education Program Q-390-687-686-721

As the student population in the United States has become more ethnically diverse in recent decades, the teaching corps has remained predominantly white and middle class. This disparity is particularly important in science and mathematics, where women and minorities have been historically under-represented. One goal of the North Cascades and Olympic Science Partnership (NCOSP) program is to increase the diversity of science teachers in the region through recruitment and retention of diverse students. A group of researchers at Western Washington University and Whatcom Community College have been investigating the experiences of students who transfer from community college to the teacher education program at WWU in hopes of better understanding how to successfully recruit under-represented populations into science teacher education.

David ClarkeLi-Hua XuCameron MitchellExploiting available technologies to align methodology and theory in the study of science classrooms
internationallyP-575-1083-1082-1116

This paper addresses the use of available advanced technology for data generation and analysis in relation to research in science classrooms. It is argued that available technologies enable a new level of alignment between research methodology and theory. Examples are provided of the types of complex data sets and associated analyses made possible by the new technologies. The theoretical and methodological entailments of the new supporting technology are discussed and illustrated with examples of recent research in science (and other) classrooms. In particular, examples are provided of multiple layers of complementary analyses made possible by advances in video analysis software. This paper addresses the extent to which available technologies support methodological approaches capable of interrogating contemporary theories of learning and instruction in ways not previously possible.

Renee Clary James Wandersee

Scientific Caricatures in the Earth Science Classroom: An Alternative Assessment for Meaningful Science Learning P-532-981-980-1014

Meaningful learning theory emphasizes knowledge integration. Scientific caricatures (SCs) were incorporated as an optional assessment tool for students in a large-enrollment Earth Science classroom at a research university. Students who participated in the SC option scored significantly higher (alpha = 0.05) than students who were assessed in the more traditional method (effect sizes 0.57, 0.36, 0.67 respectively for Exams 1, 2, and 3). Paired t-tests which compared an individual student's performance with the scientific caricature option as well as without the scientific caricature option, their examination scores were significantly higher. Content analysis of the anonymous, electronic End-of-Year Survey student responses revealed three consistent findings: (a) students enjoyed expressing key scientific caricatures required deeper integration and understanding of the material presented in class, and (c) students appreciated having such options for their examinations, whether or not they took advantage of them. We propose that SCs be employed during assessment to effectively expand the variety of methods for probing understanding, thereby increasing the mode validity of current geoscience tests.

John Clement

Multiple Time Scale Levels Of Organization For Model-Based Teaching Strategies P-506-1501-1500-1531

This paper provides a theoretical framework for organizing findings from several other studies by placing the model based teaching strategies they identify within a larger organizing framework of teaching strategies at different levels. The complex activities of teaching and learning need multiple layers of organization in order to succeed, yet they are rarely described in multiple layers. General teaching strategies were found that appear to cut across three science curricula in Mechanics, Electricity, and Biology and across different grade levels. Five levels of organization for these teaching strategies are described as a way of summarizing the findings from classrooms using the innovative curricula. Strategy levels at different time scale levels ranged from those strategies operating over months (e.g. sequence of units in a curriculum) to those operating over seconds (e.g. teaching tactics for responding to individual statements in large group discussion). The challenge here is to integrate strategies from several quasi-independent projects, to unify the vocabularies, and to link them to theories of model based learning. By separating strategies according to time scale levels, we create the potential to help teachers by sorting out different suggestions at the curriculum planning level, the lesson planning level, and the discussion implementation level.

Jennifer Coble

Curricular relevance, high stakes testing and the reality of reforming high school science classrooms P-644-1256-1255-1287

Through a series of open-ended interviews, this study investigated the beliefs of six third-year high school science teachers about how they implement science education reform ideals in their practice and the contextual challenges they face as they attempt to implement reform. The teachers argue that the lack of connection between their curricula and students lives serves as a significant obstacle to them utilizing more inquiry-based and student-centered strategies. In their science classes that are not subject to a high stakes exam, the teachers shared instances where they engage students in inquiry by reframing the focus of their curricula away from the decontextualized factual information and onto how the information relates to human experience. In their science classes subject to a high stakes test, however, the teachers confessed to feeling no choice but to utilize more teacher-centered strategies focused on information transmission. This study provides an in depth analysis of how the presence of high stakes tests discourages teachers from utilizing reform based teaching strategies within high school science classrooms.

Kabba Colley

Preparing In-Service Secondary Science Teachers in Research: Does time of offering add value? P-572-1086-1085-1119

Through an interpretative case study, this paper examined the participation of in-service secondary science teacher candidates in two research methods courses offered as co-requisites at the beginning of their academic program. The findings from the study indicated that offering research method at the beginning instead of the end of a program has added value to candidates. Candidates were able to transfer the research tools and skills learned to other courses as well. However, implementing the research method courses raise new questions about the structure and function of research method courses in secondary science teacher preparation programs.

Neporcha Cone

The effects of community-based service-learning on preservice elementary teachers' self-efficacy beliefs about equity and science teaching P-386-1089-1088-1122

Using the theoretical framework of self-efficacy beliefs, this study examined the effects of communitybased service-learning on preservice elementary teachers self-efficacy and pedagogical beliefs regarding equitable science teaching and learning. Utilizing a mixed-methods research design, data were collected from 67 participants registered in three elementary science methods courses. Section one was housed at an urban neighborhood community center and had an embedded service-learning component. Sections two and three were housed at the university s main campus and did not have a service-learning component. The results of this study support the value of preservice teachers engaging in community-based service-learning experiences as a way to improve their self-efficacy and pedagogical beliefs about equitable science teaching and learning.

Michelle CookGlenda CarterEric WiebeThe Influence of Prior Knowledge on Interpreting Graphics of Cellular TransportP-581-1152-1151-1184

The purpose of this study was to examine how prior knowledge influences how high school students (n=54) view and interpret graphic representations of cellular transport. After assessing prior knowledge using the Diffusion and Osmosis Diagnostic Test (Odom & Barrow, 1995), two graphical representations of cellular transport processes were selected for analysis. Two different methods of data collection (1) eye tracking coupled with interviews and (2) questionnaires were used to investigate differences in perceived salient features and interpretations of the graphics. The results revealed differences in how high and low prior knowledge students attended to and interpreted particle differences, concentration gradient, and the role of ATP. Without adequate domain knowledge, low prior knowledge students focused on the surface features of the graphics to build an understanding of the concepts represented. On the other hand, with more abundant and better organized domain knowledge, high prior knowledgestudents were more likely to attend to the thematically relevant content in the graphics and construct deeper understandings. The findings of this study offer a more complete understanding of how differentially prepared learners view and interpret graphics and have the potential to inform instructional design.

Laurie Cook Susan Hoban Maureen McMahon

Success Stories of African American Undergraduates with Science, Technology, Engineering and Mathematics (Stem) Careers Paths P-673-1350-1349-1381

Our study finds that mentoring is essential for African American students to persist in STEM majors. This study continues the dialog of inquiry into African Americans' lack of pursuit of STEM careers, in search of the agents leading to success rather than failure. Hines (1997) documents a common failure-centered approach to retention studies. His study focuses on factors influencing persistence among African American upperclassmen in natural sciences and science-related majors. HBCUs were not included in his study. We follow Hines' approach, but focus our study on students from HBCUs. Data collection included interviews, subject journaling and participant observation. The subjects of this study were participants in a NASA internship and had reached their junior/senior years at an HBCU, as STEM majors. The results of the ongoing analysis will be used to develop a richly descriptive account of the decision making processes and life experiences that contributed to the decision to persist in STEM majors. Preliminary findings show the students believe that mentoring is essential to their success thus far. The three female students showed the most growth during the NASA internship. This could be a result of their experience with three female scientists who mentored them during the internship.

Peter CormasJames BarufaldiKevin FlemingJessica MezeiThe Effective Research-Based Characteristics of Professional Development of the National ScienceFoundation's 1999 GK-12 ProgramP-664-1519-1518-1549

This study investigates the effective research-based characteristics of professional development (ERBCPD) of the National Science Foundation's GK-12 Program; a professional development program that supports graduate and advanced undergraduate students in science, technology, engineering, and mathematics and partners them with cooperating teachers in the K-12 classroom. An emergent content analysis and validity interviews were used to reduce a comprehensive review of studies and lists that describe ERBCPD to 16 characteristics. These characteristics were used in another content analysis (consisting of both a priori and emergent portions) to study final evaluations from 26 of 31 GK-12 sites from the program's 1999 inception year. After rigorous reliability testing, the results of the a priori portion demonstrated that the GK-12 program incorporates all 16 ERBCPD, but to drastically varying degrees. The a priori characteristics that appeared most often were treats Fellows as professionals , and involves collaboration between Fellows and others . The two emergent characteristics derived from the emergent portion included improves communication skills and has real world application. Implications of the study include that (a) ERBCPD should be used to guide GK-12 endeavors; and (b) the GK-12 solicitation program should change the outcome, improves communication skills , to a more student-centered outcome.

Frank Crawley Martha Fewell William Sugar

Researcher and Researched: The Phenomenology of Change from Face-to-Face to Online Instruction P-118-467-466-503

Online instruction, courses, and degree programs are rising in popularity in higher education and corporations. Novice and experienced instructors are facing increased demands from administrators and students to teach online, in a higher education environment long noted for face-to-face (F2F), residence-based instruction. Viewing the shift from F2F to online instruction as a transformational process, this study examines the rifts and discontinuities that emerge as one senior science educator enters the virtual world of electronic education.

Laura Creighton

Who is the Self that Teaches Science?: Looking at Identity Development in Learning to Teach Elementary Science

0-650-1271-1270-1302

Many elementary teachers have poor attitudes toward science and subsequently this negatively affects how they teach science. This study considers the potentially powerful role teacher educators can play in improving future science teachers ideas and attitudes toward teaching science. Combining insights from ethnography and discourse analysis, this study addresses how participating in a university science methods course shapes prospective elementary teachers views of themselves as science teachers. This analysis aims to help teacher educators rethink the design of science methods courses to deepen prospective teachers affiliation with science and contribute to our growing understanding of learning as a transformation of identity.

Kevin Biesinger MaryKay Orgill Kent Crippen

Achievement Goal Orientation as a Predictor for Learning in an Online Environment for Undergraduate Chemistry

P-169-273-272-309

Achievement goal theory, a component of self-regulated learning, has important considerations for the interaction of science students with online learning materials. Goal theory predicts that undergraduate chemistry students with a mastery orientation will make greater use of material provided for learning than students with a performance orientation. However, the theoretical models underpinning goal theory have been constructed using controlled study experiments and self-report data. This study sought to investigate the practical application of achievement goal orientation in the context of undergraduate chemistry by correlating self-report data with trace analysis of student behavior while online. A multiple regression analysis of data from 337 undergraduate students was completed. Students with a mastery approach orientation demonstrated the most adaptive pattern of belief and behavior while all other orientations demonstrate a negative impact on self-efficacy. Contrary to theoretical models, a performance avoidance orientation demonstrated an adaptive pattern of behavior in this context. Achievement goal orientation and self-regulatory strategies, such as use of worked examples, interacted to produce important positive changes in performance and self-efficacy while using this online system. These changes are critical for developing deep knowledge structures, as well as capable, independent learners who are confident and interested in science.

Brett Criswell Scott McDonald

An Investigation of Dead Ends as a Means of Managing the Fundamental Perplexity Frustration Tension P-651-1336-1335-1367

This paper describes a pilot study of a classroom activity structure identified as a dead end. This activity structure occurs when the events of a science lesson move the participants towards a solution to a problem which is not viable. Such a course of events can either be pre-planned by the teacher or a spontaneous occurrence. The goal of the pilot study is to develop an analytical framework for exploring the interactions taking place within this activity structure and to apply the framework to gain insight into the characteristic patterns of classroom interaction that are observed when a dead end takes place. The data for this study will initially be two videotapes of lessons presented in an introductory chemistry course. The videotapes will be analyzed using Studiocode and the analysis will occur at two levels: First at the level of lesson segments, then at the level of individual interactions between teacher and students. Initial findings suggest that there are marked differences in the way an experienced and a pre-service teacher navigate this particular activity structure that result from differences in perspective concerning the flexibility of the lesson sequence and concerning the goal of this activity structure.

Lili Cui

Assessing College Students Transfer of Learning from Calculus to Physics Using Non-Traditional Problems P-781-1683-1680-1710

This research investigated students transfer of learning from calculus courses to an introductory physics course using non-traditional physics Jeopardy problems. We used semistructured think-aloud interviews to assess the extent to which students transfer their calculus knowledge when solving Jeopardy problems. Jeopardy problems present interviewees with an intermediate step in the form of a mathematical integration and ask students to come up with a physical scenario relevant to the integral provided. Results indicate that students often had difficulty taking apart the given problem and constructing the corresponding physics situation.

Paul CuthbertBrian LewthwaiteThomas OwenI want to enable teachers in their change': Exploring the influence of a Superintendent on Science DeliveryP-240-396-395-432

This research inquiry explored the factors influencing successful science program delivery among earlyand middle-years schools within a rural school division in central Canada. The study is framed by the author' personal inquiry into how psycho-social factors at the classroom, school and school division level influence science program delivery. In line with case study methodology, the inquiry uses a variety of qualitative and quantitative methods and data sources to identify the contributors at the classroom, school and divisional level to science delivery. A validated science program delivery evaluation tool, the Science Curriculum Implementation Questionnaire (SCIQ), is used as the foundation for the quantitative data collection and ensuing teacher, administration and science education community discussions. Bronfenbrenner s bio-ecological model and Rutter s views on resiliency are used as a framework for interpreting the data collected and understanding the factors supporting successful science delivery. Participants identify a variety of personal attribute and environmental factors and the interplay between these factors as supportive factors contributing to effective science delivery at the classroom, school and divisional level. Implications of this inquiry are discussed, especially within the context of the role of the superintendent in influencing curriculum delivery.

Zoubeida Dagher

Towards a more inclusive account of authenticity in school science inquiry P-378-1498-1497-1528

No other construct has consistently dominated the science education literature as inquiry. Whether in its rudimentary or more sophisticated permutations, conceptualizations of inquiry can be strong shapers of intended curricula. The prominent space inquiry has claimed in recent reform documents reflects its perceived value for promoting scientifically literate citizens. Our understanding of the nature of scientific inquiry continues to grow with improved understanding of the various methods and arguments scientists use in their work. Our conceptions of how to implement components of scientific inquiry in developmentally appropriate ways to K-12 students seem to evolve at a slower rate due to the complexity involved in simplifying complex ideas. This paper raises issues concerning the adequacy of Chinn and Malhotra s (2002) model of scientific inquiry raising questions regarding the scope of authentic inquiries it subsumes. In the paper, I make the case that this model applies to experimentally oriented inquiries and does not account for inquiries that rely on historical reconstructions, thus leaving out from consideration an inquiry genre that is worthy of recognition and accommodation.

Chanyah DahsahRichard CollBronwen CowieSunan Sung-ongNaruemon YutakomSudjit Sanguanruang

Enhancing Grade 10 Thai Students' Understanding and Solving Numerical Problems in Stoichiometry Using a Conceptual Change Approach P-127-489-488-525

Stoichiometry lies at the heart in quantity chemistry, as it includes the concepts that are essential for understanding and solving chemical problems. The literature suggests that many students have difficulty in understanding and applying the stoichiometry concepts, and they often resort to the use of algorithms to solve stoichiometry problems without understanding of the concepts. In prior work we identified student alternative conceptions for stoichiometry, and here we report the development of a series of stoichiometry learning units (SLUs) which seek to enhance students' understanding of, and problem-solving skills in, stoichiometry. Conceptual change theory was used as the theoretical based for the development of the units, in which we drew upon a situation analysis of students' understanding and problem-solving skills, along with observation of teaching and learning when designing the SLUs. The SLUs comprises 16 units covering

all concepts in the Thai curriculum. The units were implemented in three Grade 10 science classrooms (ca. 50 students per class). Multiple data gathering techniques were employed in order to evaluate the units. The results suggest that the units offer an alternative for the teaching and learning of stoichiometry, and that they help students understanding stoichiometry concepts and enhance their problem-solving skills.

Shanna Daly Lynn Bryan Nick Giordano

Middle and High School Teachers' Conceptions Regarding the Use of Models for Nanoscale Science Instruction Q-617-1488-1487-1518

Teaching and learning science often utilizes models and modeling activities. Nanoscale science education relies heavily on physical representation models because students cannot explore nanoscale phenomena via photographs, light microscopes, or demonstrations; only the resulting micro- or macroscopic effects can be seen. The National Center for Learning and Teaching Nanoscale Science and Engineering (NCLT) is committed to the integration of nanoscale science into pre-existing grades 6-16 curriculum. Integration depends on teachers nanoscale pedagogical content knowledge, which relies on successful development and use of nanoscale models and modeling activities. NCLT professional development workshops use a design-based research framework which aims to bring design and research activities into tight relation to advance our understanding of learning-related educational phenomena (Bell, 2004, p. 245). This particular study focused on science teachers' pedagogical understanding of models and model use in their classrooms, with emphasis on models of nanoscale phenomena. Data from this study indicated that the criteria teachers considered when choosing a model were based primarily on scaled or structural models, as opposed to casual models. They did not select nanoscale models based on the compatibility of these models with inquiry methods, and they did not prioritize the criteria of concept correctness in choosing their models.

Rebekka Darner

The Use of Self-Determination Theory to Foster Environmental Motivation P-75-543-542-579

Plausible solutions to environmental problems are rooted in science. Through scientific understanding, it is possible to analyze our roles in ecological and sociological systems and devise environmental solutions. However, one must possess an impetus toward behavioral change in order for those solutions to be realized. This study is a preliminary attempt to apply a well supported theory of motivation, self-determination theory (SDT), to formal environmental education (EE). The research question was: To what extent does an SDT-guided course differ from a non-SDT-guided course in the degree to which it fosters self-determined motivation toward the environmental biology course. The instruction in one section was guided by SDT, while the other was taught as it usually is. Post-test scores were compared through analyses of covariance using the pre-test scores as a covariant. Analyses indicated that the SDT-guided section. Students who entered the course lacking environmental motivation also showed a greater improvement in the SDT-guided section. Features of SDT-guided instruction and the utility of SDT to guide EE research will be discussed.

NARST Annual International Conference 2007

Elizabeth DavisCarrie BeyerCory Forbes

Shawn Stevens

Promoting Pedagogical Design Capacity through Teachers' Narratives P-487-880-879-914

Teachers need to develop the ability to adapt curriculum materials. This paper explores the ways in which three elementary teachers who were asked to write narratives about their use of particular lesson plans described the changes they made to the curriculum materials, and how the construction of these narratives contributed to their development as professionals. For example, Maggie draws extensively on her knowledge of and experiences with her students, as well as other knowledge, experiences, and resources, to make productive changes to lesson plans to account for her students' prior knowledge and abilities. The process of writing these narratives served as a professional development experience for the teachers. For example, Maggie became more aware of and articulate about the role of modifying curriculum materials in her professional identity. The paper concludes with a discussion of implications for the design of teacher education, professional development, and educative curriculum materials.

Kathleen Davis Mary Mawn

Seeing the Forest through the Trees: Elementary and Middle School Teachers Learning Science in an Online Biology Course Q-285-528-527-564

This paper investigates how project-based instruction, used in an online biology course, influenced teachers learning of inquiry skills and biological and ecological content knowledge. Teachers investigated 'driving questions' related to key ecological topics (e.g., populations, community, ecosystems, succession) through several projects: A Year in the Life of a Maple Tree, Compost Column, Schoolyard Enhancement Plan, and an open-ended project. Qualitative methods were used and data includes structured and semi-structured interviews, surveys, course discussions, teacher journals and portfolios, and course documents. Findings from the study indicate that: 1) teachers acquired key biology/ecology-related concepts. 2) Teachers consistently made linkages between their investigations and their everyday lives, which fostered their learning of science content. 3) TikiWiki, an open source Content Management System/Groupware web application used for reporting and discussions, allowed teachers to effectively communicate observations of their inquiry activity using text (journals, online discussions, and portfolios), digital images, and other methods, which was instrumental to their learning of science content and inquiry skills. 4) TikiWiki, which was not used in other courses of the online masters program, was difficult and time-consuming for some teachers to learn. 5) The use of online portfolios facilitated teachers reflection of their science processes leading to additional learning.

George DeBoerCari Herrmann AbellArhonda GogosThomas ReganPaula WilsonSean Smith

Assessment Linked to Science Learning Goals: Probing Student Thinking Through Assessment S-91-263-262-299

In a standards-based environment, assessment needs to provide accurate information on how well students are meeting pre-established learning goals, but assessment must also provide guidance regarding what students already know, what they are capable of learning, and the coherence of the learning goals themselves. The aim is for students to develop a progressively more interconnected set of ideas that are useful for explaining the physical world and that are functional for acquiring new knowledge. Assessment can probe student understanding by searching for critical gaps in their knowledge and by sorting out what the critical components of a useful mental model are. This symposium will address how to develop assessment items that precisely measure student understanding of the ideas specified in the AAAS Benchmarks for Science Literacy and the NRC s National Science Education Standards at the middle school level, and how it can be a tool in the clarification of those learning goals. We will focus particularly on how feedback obtained from students through pilot testing provides information about what students do and do not know and the appropriateness of certain learning goals in five middle school topic areas.

Cristina DeFranco Bhaskar Upadhyay

Using Hmong Students Funds of Knowledge as Resource s for Teaching Empowering Science Q-179-1414-1413-1445

This study explores how a Hmong female elementary teacher enacts science curricular choices to empower students and why she believes that using Hmong students funds of knowledge during science teaching is empowering to the students. I use the theoretical frameworks of funds of knowledge (Moll & Greenberg 1998) and Banks (1991) and Greene s (1993) idea of empowerment.

Akiko DeguchiShigenori InagakiEtsuji YamaguchiHideo FunaoiThinking Process Based Reflection Promotes Conceptual Change: In the lesson of Three States of MatterUsing Concept Mapping Software for Reconstructing Learning ProcessesP-317-739-738-773

In recent studies such as Intentional Conceptual Change (Pintrich & Sinatra, 2003), it has been argued that conceptual change includes learner s intention. In the studies, reflection is believed to promote conceptual change. In our study presented at NARST 2006, we confirmed that 'reflection on the thinking process' using software-based concept maps promotes more conceptual change than 'reflection on the concept at present' using conventional paper-based concept maps. But little is known WHY and HOW does 'reflection on the thinking process' promote conceptual change. In this study, we introduced our concept mapping software into lesson about Three States of Matter into a fourth grade class, to analyze data recorded by the software and audio recordings about students' conversations. Through quantitative analysis of all students' conceptual changes and qualitative analysis of student N's conceptual change, results was summarized that reflection on thinking process does not facilitated it about materials scheduled for learning in the next phase. Applying the theory of Intentional Conceptual Change to our results, it can be said that reflection on thinking process about a given lower-level concept can be mobilized to intentionally change another related lower-level concept.

Cesar Delgado Shawn Stevens Namsoo Shin Molly Yunker Joseph Krajcik Students' Conception of Size P-645-1358-1357-1389

Scale is an important common theme that can link student understandings across topics, disciplines, and grade levels. Scale is essential to nanoscale science and engineering, an emerging field that needs to be incorporated into the science curriculum. This study builds upon recent, seminal research into how people understand scale and the related concept of size. Interviews, card sort tasks, and focus groups are employed to examine how learners conceptualize size in four ways: grouping by size (categorical), ordering by size (non-quantitative relative), how many times bigger one object is than another (quantitative relative), and size using measurement units (absolute); and whether and how learners connect these four conceptions of size. It also studies what learners know about objects too small to see, the units to express their size, and the sources of this knowledge. The population includes predominantly minority, economically disadvantaged middle and high school students in a Midwestern town, and experts. This study begins to trace a learning progression for size and scale, with ultimate outcomes established by the performance of the experts interviewed. It also sheds light on students understanding of ratio and proportions, a problematic but crucial math concept. Implications for curriculum design and instruction are presented.

Abdulkadir Demir Sandra Abell

What does Inquiry Mean to Beginning Science Teachers of an Alternative Certification Program? P-708-1459-1458-1490

The purpose of this phenomenongraphic research study was to: (a) gain an understanding of the meaning of inquiry held by beginning science teachers recruited through an Alternative Teacher Certification Program (ATCP) from various science disciplines; (b) understand how they implemented inquiry during their initial years of teaching; (c) identify the relation between what they learned in their ATCP and their practice of teaching science through inquiry. The participants of this study consisted of four ATCP teachers who were in their beginning years of teaching. As source of data collection, we used semi-structured interviews, classroom observations, field notes, and artifacts. We applied an iterative data analysis process and presented our findings in the form of profiles of the research participants. From all profiles, we constructed a set of assertions. The analysis showed that beginning science teachers valued inquiry and attempted to incorporated inquiry-oriented activities. They believed that inquiry is student driven, with students asking questions, designing investigations, and collecting data. Also, not only did they hold an incomplete meaning of full inquiry and guided-inquiry, but also they misunderstood what is meant by inquiry (e.g., Inquiry = 5E instructional model; Discovery; and Verification).

David DesjardinsKaren SullengerRobyn SmartAttitudes about and Interest in Science: An After School Research Program for Elementary and Middle SchoolP-517-1306-1305-1337

Researchers continue to find that middle school students show a dramatic decrease in interest in and attitudes towards science in middle school. This paper examines attitudes towards and interest in science by school children through the development and execution of two after- school programs; one elementary-based themed on bugs and the other middle school-based themed on EcoAction . The students are engaged in a series of planned activities and research is conducted on their ideas and concepts as they relate to both science and scientists. Teachers are also engaged in the process and evaluated with respect to the impacts that these programs had on students in the program throughout the school year. The program is a longitudinal study over five years designed to research the cumulative effect on students based on continued participation in an after school program. Evidence is offered on those factors identified in the first phase of the programs that result in increased performance, improved attitude, and interest in science.

Daniel DickersonAmy AdcockKaren DawkinsThe Role of Groundwater in Students' Understandings of Our EnvironmentP-307-522-521-558

This study examines student conceptions of groundwater principles and use. We employed a mixedmethodology that included the use of a researcher-developed instrument comprised of a drawing prompt and nine open-ended questions. Participants provided responses that suggest that they possess little understanding of groundwater and do not see it as part of a larger system. Implications exist for environmental and earth/environmental science educators including calling for a greater emphasis on groundwater in formal/informal science education and environmental education contexts as well as reform regarding instruction focused on water cycles and the environmental significance of subsurface hydrology. Daniel DickersonDavid SlykhuisKaren DawkinsExamining Cultural Understandings of the Relationship between Intelligent Design and Nature of ScienceQ-307-526-525-562

We were interested in examining how misconceptions about NOS manifested themselves in responses related to readings about Intelligent Design in the context of participants' specific faith cultures. We conducted a mixed-methods study that included researcher developed open-ended items and videotaped semi-structured interviews. We provided a researcher-designed assignment created to supplement prior NOS instruction through an explicit-reflective-integrated approach. Once the data were coded, categorical aggregation was conducted to identify patterns and anomalies. The participants expressed ideas regarding the relationship between science and religious faith that appeared to be related to their understandings of NOS. They also provided evidence suggesting how they anticipate these understandings will impact their teaching. Implications for science teacher educators may include an increased focus on the teaching and learning of NOS in science methods courses. These findings may also signal a need for increased opportunity for science educators to explore issues regarding the relationship between science and religious faith an opportunity may impact teacher pedagogical-content knowledge and multicultural education practices by building awareness of the diversity of views regarding relationships between science and religious faith.

Maurice DiGiuseppe

Exploring Author-Editor-Publisher Perspectives and Interactions Regarding Representations of the Nature of Science in the Development of a Contemporary Science Textbook P-453-1565-1564-1594

Current reforms in pre-college science education call for students and teachers to develop more informed views of the nature of science , a process in which science curricula and science learning materials like textbooks, each powerful and pervasive communicators of particular views of the NOS, play a significant role. Textbooks are developed by teams of collaborating authors, editors, and publishers shape the textbook s contents according to their particular pedagogic, philosophic, professional, and political views, values, interests and beliefs. For future science textbooks to communicate more informed representations of NOS, their developers require information regarding contemporary NOS understandings; need to interpret, make sense of, and negotiate the significance of these new ideas; and incorporate them into their developing textbooks in the most meaningful and pedagogically appropriate manner possible. This paper reports on a collaborative action research project in which the developers of one unit of a high school chemistry textbook attempted to better represent the nature of science. In the study, I examined the multiple discourses that arose in the collaboration as developers reflected on, reviewed, and revised their NOS understandings; squared these with mandated curricula, the educational needs of chemistry teachers and students, and the exigencies of large-scale commercial textbook publishing.

Justin Dillon

Developments in EE & Informal Science P-772-1664-1661-1691

This invited symposium hosted by the new environmental education strand (14) will consider the unique contexts that environmental education may provide for science education and its associated research. The discussion will be prompted by brief presentations from invited panelists (above) that will examine the historical, present and future condition of environmental education activities at NARST. Participants will engage in facilitated discussions aimed at building capacity within the new strand while working towards a shared vision for future research dissemination activities hosted by the environmental education strand.

Justin Dillon

Issues and trends in science teacher professional development in Europe P-784-1691-1688-1718

This seminar will examine professional development of science educators from a variety of perspectives. BouJaoude and Dillon will present the preliminary results of a survey of the readership of science education journals worldwide that aimed to determine the extent to which science educators learn from the experiences of international colleagues. Fraser-Abder will present a global perspective on professional development activities that provide a forum through which teachers can hone their skills, develop, support, and begin to address the specifications of working with their schools . Dillon s contribution will focus on the variation across Europe in terms of science professional development while Hofstein and Mamlok-Naaman will discuss three models of professional development used with Israeli science teachers. Finally, Abd-El-Khalick will focus on professional development for Egyptian teachers by describing two realizations of the Professional growth through engagement model used in large and small scale educational reform projects in Egypt.

Erin DolanChristine LuketicJulia GradyDefining Authenticity within a Student-Teacher-Scientist PartnershipP-302-1294-1293-1325

rtnersnip

Amy Germuth

Using an instrumental case study approach, we describe a research partnership among a high school teacher, her students, and a scientist as a mutually-beneficial relationship because of its bi-directional nature and execution as well as its consideration of the needs and resources of all partners. We propose that the partners belief that they are both deriving and contributing benefits underpins their recognition of the relationship as authentic. We examine data collected from classroom observations, student and teacher interviews, student work, and teacher and scientist reflections to yield insights into the ways that partners (a scientist, a teacher, and her students in one classroom) identify their collaboration as authentic. Our findings suggest that, in this case, two inter-connected layers of authenticity are developed through such a partnership: the authenticity of the science research and the authenticity of the relationship.

Joel Donna Fred Finley

Novice teachers changing conceptions of student centered, inquiry based science education and ELL practices as a result of an international science teaching experience. P-723-1539-1538-1569

This study examines the impact of a short term teaching internship in Thailand on novice science teachers conceptions of teaching, beliefs about the use of inquiry, and practices related to ELL teaching. Five novice teachers traveled to Thailand to help Thai teachers and education officials with the Thai educational reform movement that mandates increased student-centered instruction. Using, pre-experience interviews, teaching observations, reflection reports, and post interview data, cases were formed for the individual participants and themes emerged across the cases. Participant experiences in a culture that highly values its teachers helped them envision their future classrooms as a respect filled environment in which high standards for all could be achieved. Participant observations of teacher-center practices and reflections on their own teaching experiences helped reinforce student centered practices and beliefs. Although some participants used guided inquiry activities successfully in their internship, their still remain hesitant to use it in their future classrooms. None of the participants mentioned the value of using inquiry with ELL learners in their final reports and post interviews. However, all participants felt that this experience was extremely valuable in helping them improve their ability to work with ELL students.

Lisa DonnellyMahsa KazempourAidin AmirshokoohiStudent Perceptions of Evolution Instruction: Interrelationships of Understanding, Acceptance, and
Learning Experiences

P-407-717-716-751

Evolution is an important and sometimes controversial component of high school biology. conceptual difficulties and conflicts with students' religious views can influence students' evolution learning experiences. High school biology students' views can be particularly useful for improving evolution instruction. In this study, we explore students' evolution understanding, acceptance, and views of evolution teaching and learning. Students explained their acceptance and rejection of evolution in terms of evidence and conflicts with religion and authority. Students largely supported the teaching of evolution and offered several reasons for its inclusion in high school biology. Students also offered several suggestions for improving evolution. Taking these students' reasons and suggestions seriously may on the one hand show respect for the multiple perspectives that exist within a classroom and on the other hand allow teachers to appeal to students' reasons to improve and justify evolution instruction.

Lisa Donnelly Valarie Akerson

Intersections of Evolution, NOS, the Demarcation of Science from Non-Science: The Views from a High School Biology Classroom Q-407-716-715-750

Evolution is an important context for teaching about nature of science, and nature of science serves as an important tool for evolution instruction. As such, students' views of NOS in the context of evolutionary content may be particularly informative for the development of sound science curricula. This study employed a mixed methods approach for investigating high school students' evolution acceptance, views of the demarcation of science from non-science, views of NOS, and ideas about evolution teaching and learning. The results suggest that students employ NOS and demarcation concepts readily when they justify their acceptance and rejection of evolution, their views on the teaching and learning of evolution, and their views of the relationships between science and religion. Evolution rejecters employed NOS conceptions much more frequently than did evolution acceptors. The NOS conceptions most frequently (correctly and incorrectly) employed included tentativeness in science, the nature of scientific theories, the bounds of science, the empirical nature of science, and social and cultural influences on science.

Deborah Donovan Brad Smith

Developing Reformed Science Curricula for Higher Education and Professional Development Settings P-288-479-478-515

One product of the North Cascades and Olympic Science Partnership is the development of new Life science and Earth science curricula for both teacher preparation and teacher professional development. This multi-paper set will address the development, implementation, and outcomes of the process. In particular, this second paper of the set describes the development of two courses, one for Life science and one for Earth science, that incorporate interactive engagement throughout and follow the model used by Physics for Elementary Teachers. Problems specifically related to using this type of curriculum in the Life and Earth sciences are discussed.

Sharon Dotger

Reflective Judgment & Nature of Science: Commonalities Explored P-753-1609-1608-1638

Three hundred and twenty three individuals ranging in educational attainment from early high school through graduate school participated in this study. Each participant completed assessments of their understandings of nature of science (NOS) and of their reflective judgment. NOS understandings were evaluated to look for differences in response based on educational level, college major, and reflective judgment using multinomial ordinal regression. Results indicate that college major had no impact on the NOS views of the participants for 9 of the 10 questions asked. While higher educational attainment was associated with improved NOS understandings for half of the questions, reflective judgment scores were associated best with improved NOS understandings and in several cases demonstrated the stepwise improvement predicted by the reflective judgment model (King & Kitchener, 1994). The commonalities of these results are discussed and ideas for further research are presented.

Patrick Dowd

The Impact of Identity on the Pedagogical Practice of Environmental Educators Q-607-1268-1267-1299

By looking into the connection between an environmental educator s different life roles and how they choose to educate others, we can come to better understand how these roles are socially mediated and positioned. This poster will cover work undertaken to understand how individual identity and the naturalist/ interpreter role at nature centers are linked. The findings of the study suggest a positive link between role awareness and educational best practice at two nature centers in the UK. Thus, this poster will address how an understanding of the concepts of identity and roles can be used to improve the design and implementation of pedagogical practice at informal institutions and subsequently the visitor experience as a whole.

Constance Doyle

Lesson Study and Its Relationship to Science Content P-747-1595-1594-1624

Learning to teach specific science content is important in the preparation of preservice elementary teachers, and building pedagogical content knowledge during teaching practicums is desirable. Lesson study, which originated as a professional development model in Japan, can be a useful tool for helping preservice teachers examine their teaching. This research explores the connections between lesson study, science content knowledge, and the creation of pedagogical content knowledge. Results suggest that with support from others who are knowledgeable about science content, preservice teachers can revise lessons and create content specific strategies to ameliorate weaknesses in elementary students understanding of science content. Results also suggest that in some cases management concerns can overshadow concerns with student learning, and lesson study may also be valuable in helping preservice teachers address such concerns.

Oliver Dreon, Jr.

Scott McDonald

Negotiating Contradictions: The Development of Professional Identity through Participation in a Community of Practice P-79-439-438-475

Research has shown that teachers professional identity contributes to their self-efficacy, motivation, commitment and job satisfaction. This study examines the development of prospective teachers professional identity as they participate in a community of practice focused on integrating educational research with science pedagogy to understand and enact inquiry science. Through the analysis of data collected through interviews and reflective web logs, prospective teachers demonstrated contradictory didactic and subject matter identities. In these areas, the participants appeared to struggle with the identities they had developed through their high school and collegiate learning experiences and their developing identities as inquiry-oriented science teachers.

Reinders Duit Silke Mikelskis-Seifert

Physics in Context A Professional Development Project for Improving Physics Instruction in Germany P-140-453-452-489

Developing teachers ways of thinking about good instruction as well as their views of the teaching and learning process are generally seen as essential for improving teaching behaviour and implementation of more efficient teaching and learning. The framework of a German quality development project that explicitly draws on this position and results of the evaluation will be presented. Key goal of the project is to improve the range and quality of teachers thinking about teaching and learning physics as well as their teaching behaviour by developing and introducing new teaching and learning methods, new media and new content structures of certain topics. Major deficiencies of German physics instruction as revealed by a nation wide video study on the practice of instruction are addressed. The process of developing teachers thinking is deliberately supported. Teachers are made familiar with recent (constructivist) views of teaching and learning and instructional methods that allow to set these views into practice. Evaluation resulted in partly encouraging findings regarding the development of student affective and cognitive variables and concerning teacher professional development. However, it turned also out that many teachers ways of thinking about good instruction did only developed to a limited degree.

Emilio DuranLena Ballone-DuranSvetlana BeltyukovaJake BurgoonChristine FoxMandy Heddle

The impact of a professional development program entitled NWO-TEAMS (Teachers Enhancing Achievement on Mathematics and Science) on the content knowledge and teaching skills of elementary and middle school science and math teachers P-712-1478-1477-1508

The purpose of the study was to evaluate the impact of a professional development program entitled NWO-TEAMS (Teachers Enhancing Achievement on Mathematics and Science) on the content knowledge, beliefs and skills of elementary and middle school science and math teachers by modeling activities that are constructivist in nature and by using research-based materials to engage the participants in hands-on, mindson scientific inquiry. One of the strengths of this program resides in the utilization of teams of scientists, mathematicians, and educators as the faculty involved in teaching content and pedagogy to the teacher participants. These participants were recruited in teams from the same school/building to create a critical mass of leaders interested in science and mathematics reform. Both quantitative and qualitative analyses of the NWO-TEAMS model support that teacher beliefs and skills were positively and significantly impacted. We are planning follow-up studies to assess whether or not these teacher beliefs are sustained over time. For example, classroom observations of teachers coupled with interviews might further reveal if and how efficacy and inquiry beliefs are enacted in the classroom. Lastly, teacher content knowledge was also positively affected, especially in grades 4 and 6, as evidenced by the significantly higher scores in the posttests.

Richard Duschl Okhee Lee Brian Reiser Kathleen Roth Jonathan Osborne

Andrew Shouse

Learning science in grades K-8: A new research synthesis S-304-599-598-635

In Fall 2006 an independent national scientific advisory group will release a new report on students science learning in grades K-8. The report, Taking Science to School: Learning and Teaching Science in Grades K-8 is reflects a three year fact-finding and deliberative process involving a committee of 14 experts. This major research synthesis, supported by the National Science Foundation, The National Institutes of Health, and the Merck Institute for Science Education, is conceptualized in the tradition of previous synthesis studies such as How People Learn (NRC, 2000) and Preventing Reading Difficulties in Young Children (NRC, 1999). The report will synthesize evidence from several disciplines including developmental psychology, cognitive science, science education, and history and philosophy of science to develop a road map for improving science education and lay out next steps for research. The proposed symposium will provide a capsule summary of the volume s findings and conclusions, expert commentary from invited respondents, and opportunities for attendees to dialogue with expertswho contributed to the report.

Richard DuschlNancy BrickhouseFouad Abd-El-KhalickPhilip BellDaniel EdelsonRichard Grandy

Inquiry and the Learning of Science Theories and Practices S-94-583-582-619

The proposed symposium will report on a federally funded working conference that examined and debated the character and role of inquiry in school science. Following the presentation of the conference plenary paper, Day one was devoted to Philosophical Issues and Next Steps for Research, and day two to Policy, Practice and Next Steps for Educational Research. Conference participants included philosophers, psychologists and educational researchers. The main objectives of the symposium are to share consensus points from the Inquiry Conference (presentation 1) and to extend critical discussions of core issues raised at the conference (presentations 2-4) regarding:(1) The design of instructional sequences that develop scientific reasoning and thinking; (2) The version of scientific methods that best supports school science inquiry; and, The important research problems and questions surrounding the implementation of immersion units, the structure of learning progressions, and the selection of epistemic goals therein.Presenter 1 - Consensus Views on School Science Inquiry Presenter 2 - Social Epistemology and InquiryPresenter 3 - Model-based and Authentic Inquiry Presenter 4 - Reading and discourse as InquiryDiscussants: A philosopher of science and an educational researcher

Jazlin Ebenezer Osman Kaya

Scientific Inquiry with Information Technologies: High School Students Experiences P-110-224-223-260

This initial study focused on high school students experiences about their understanding of, and abilities necessary to do scientific inquiry, two foci emphasized by the National Science Education Standards in the strand on science as inquiry. The research method consisted of Likert-scale survey with space provided for students comments about the two parallel foci of science as inquiry. The data were collected from 45 students (29 females and 16 males) from Grades 9 to 12. The results of this study has indicated that on the average 82.06% and 78.71% of the students developed better understanding of, and abilities necessary to do scientific inquiry, respectively. These increases were further supported by evidence from qualitative data. This study lays the foundation for future studies on mapping learning progressions on scientific inquiry with information technologies. This study reiterates the need to emphasize the importance of how do we come to know what we know in science .

Christopher Edmin

The school, the class, and the laboratory: Intersecting culture for science teaching and learning P-173-1415-1414-1446

This paper presents the amalgamation of school and classroom culture in the science laboratory of an urban school. Through the provision of a theoretical and qualitative analysis of students culture, both in out of laboratory fields, I describe the emergence of exchanged culture throughout each of the arenas where students interact. In addition, I describe the emergence of an organically created cosmopolitan culture within the laboratory field. These discoveries have led to a discussion of the ways that the science laboratory has facilitated student agency, learning, and interest in chemistry. Furthermore, I provide a rationale for studying the ways that students communicate within the laboratory by addressing its benefits to students engagement in science both in, and out of laboratory fields. Rather than drawing conclusions about the culture produced in the laboratory by merely studying videotapes of students, I utilize cogenerative dialogues as a tool for investigating incidences that appear to be transformative learning experiences for students. In these dialogues, students describe how opportunities to engage in communal practices drive their interest in science and the laboratory. They also explain how they manage to navigate the rigid structure of the laboratory while developing connections to science and each other. This study suggests that, when given the opportunity to do so, students are able to collectively create and appropriate laboratory protocol that meets the needs of both peers and instructors.

Elizabeth Edmondson William Leonard

Collaborative Dialogue: Exploring 4th Graders' Discussions of Science P-466-927-926-960

Opportunities for students to more fully participate in scientific inquiry and to experience the nature of science are critical to scientific literacy. The worldwide web has made it possible for teachers to expand their classroom dialogue to engage students in other classrooms. This dialogue provides students with an opportunity to share findings and conclusions, expose ones ideas to criticism, question each others thinking, and other components of the nature of science. These researchers studied the collaborative dialogue between three classrooms, who completed similar investigations, to determine the impact of the dialogue on student understanding of scientific inquiry and the nature of science. A qualitative case study approach was used to examine student writing, the teaching of lessons, and teacher interviews. The students successfully created responses to investigation prompts and responded to their partner s entries. While they understood that their behaviors modeled those of scientists more closely than they had in the past, they were only able to make minimal connections with the specific ideas promoted by the nature of science. The role of the teacher, curriculum, and writingprompts provides insight into these results and allow for recommendations for future work.

Michael EdwardsKaren SullengerCarla ShawJeannine ClarkElementary Students' Perceptions of Scientists Versus Themselves Doing ScienceP-517-1296-1295-1327P-517-1296-1295-1327

There is much literature describing students views of scientists, especially, using drawings. However, there is little known about their views of themselves as scientists or doing science. This paper describes what we learned from approximately 110 elementary students about their understanding of doing science and what they perceive as scientists doing science. We found that these children do draw and describe themselves and scientists doing science differently. More interestingly, we found that their ideas about doing science changed as they participated in the program. This paper also raises the questions, What should count as doing science?

Janice Eibensteiner

Conceptual and Procedural Knowledge Community College Students Use When Solving a Complex Science Problem

P-165-275-274-311

A strong science knowledge base and problem solving skills have always been highly valued for employment in science industries. Successful science students have mastered their field of study by being able to apply their learned knowledge and problem solving skills on tests. Problem solving skills must be used to figure out the answer to many classes of questions. What this study is trying to determine is how students solve complex science problems in an academic setting in order to inform the development of problem solving skills in the workplace. Students use of problem solving skills in the form of learned concepts and procedural knowledge was studied as students completed a possible real life problem. The research questions answered were 1) How well do community college students use a complex of conceptual knowledge when solving a complex science problem? 2) What conceptual knowledge are community college students using correctly, incorrectly, or not using when solving a complex science problem? 3) What problem solving procedural knowledge are community college students using successfully, unsuccessfully, or not using when solving a complex science problem? The implications of these results for instruction in science education problem solving will be discussed during the presentation.

Jennifer Eklund **Aaron Rogat Nonye Alozie** Joseph Krajcik Promoting Student Scientific Literacy of Molecular Genetics and Genomics

P-638-1257-1256-1288

As the fields of molecular genetics and genomics have boomed and become increasingly important in the lives of the general public, traditional education methods have struggled to address the challenges in developing modern genetics literacy. To aid understanding of how to help students learn fundamental concepts in modern genetics, we report on the initial enactment of an inquiry-based unit focused on these concepts. The unit differs from traditional materials by focusing on proteins and genes as well as the relationship between them. The unit also incorporates features educators believe can aid science teaching such as a focus on learning goals, and the inclusion of contextualization. We report on teacher use of the materials, students' response to and use of the materials, and student performance. We found that teachers did not use all of the instructional suggestions, skipped some activities and did not adequately use contextualizing features. We were able to identify engaging and motivating phenomena for students, as well some representations that appeared to be helpful to student learning. While students made gains in some areas, other areas remain challenging. Several instructional suggestions were identified that could aid student learning of molecular genetics and genomics.

Ramez Elgammal	Lincoln Lauhon	Denise Drane	Gregory Light
Development of a Nanoscier	ce Conceptual Inventory		
P-599-1397-1396-1428			

Conceptual inventories, such as the Force Concept Inventory (FCI), have had marked success in both identifying student misconceptions and measurably improving introductory physics curricula and pedagogy at many universities. In the spirit of the FCI, we have developed a Nanoscience Concept Inventory (NCI) geared towards introductory undergraduate courses to meet the need of understanding student misconceptions and alternative conceptions in this burgeoning field. Nanoscience by its nature is multidisciplinary and requires assimilation and synthesis of all of the sciences. Thus, it presents a challenge for educators that lack the subject matter knowledge and an appreciation for the nuances of the nanoscale. The NCI is a multi-tiered and ordered device and was built using conceptual mapping that contains conceptual trajectories centered on the following core areas: size and scale, the particulate nature of matter, the unique properties at the nanoscale, modeling and tools, and self-assembly. Our hope is that the results from the NCI will aid in construction of new curricula to help correct student s flawed mental modes and develop a scientific acumen necessary to become literate in nanoscience and nanotechnology.

Doris Elster

Teachers' Voice in School-based Initiatives in Austrian Schools P-99-1166-1165-1198

In the project EUDIST (European Development of Innovative Science Teaching) Austrian science teachers collaborate with researchers of the university by using an approach to professional development that is called the Curriculum Workshop (CW). This is a discoursive approach to school improvement and curriculum development with teachers as central agents. The method of the CW is based on theories of curriculum deliberation and justification (Frey, 1983), procedural ethics (Oser, 1992) and structured argumentation in problem solving (Toulmin, 1958). This CW approach is linked-up with methods of action research (Altrichter & Posch, 1998). The underlying intention is to empower teachers as reflective practitioners Schön 1987). The teachers are called upon to draw up reflective papers adopting a research approach towards their own practice. In a sequence of Curriculum Workshop meetings they exchange views with educational researchers and representatives of the local school authorities. The results of these discussions are put down in a final curriculum document which provides a valuable basis for effective school-based teacher education allowing the participating teachers to gain a high degree of professionalism with regard to innovative school development and to be taken seriously as players in the process of educational reforms in science education.

Mark Enfield

Could That Really Happen? Elemntary Inquiry Around Informational and Narrative Texts Q-602-1177-1176-1209

Attention to literacy has raised attention to the use of texts in science learning. Elementary teachers are encouraged to use informational texts in their science teaching. Students need to learn to read and make sense of information from these texts. Concurrently science educators focus on helping improve the inquiry skills and practices taught in schools. An assumption is that children can learn about inquiry by using informational texts to find answers to questions. This research describes findings from a longitudinal case study of one classroom. The findings suggest that students tend to raise questions and engage in inquiry oriented activity when responding phenomena represented in narrative texts. Students utterances raise questions or attempt to explain phenomena occurring in narratives. In comparison, students responses to informational text tend to be conceptual. Students utterances made limited connections to phenomena and did not offer explanations or inquiries about phenomena. The findings reported here suggest a role for carefully selected narrative texts as contexts to engage students in meaningful inquiry about phenomena. This does not reject informational texts as valuable, but restructures notions about how different text genres are meaningful and useful in science learning.

Handan Eskin Feral Ogan-Bekiroglu

Effects of Promoting Argumentation on Students' Reasoning in Physics P-693-1394-1393-1425

The purpose of this research was to examine the effects of implementation of argumentation in a physics classroom on students' reasoning. This research is both quantitative and qualitative in nature. Experimental design was used for the study. For the quantitative aspect of the research, students' prior knowledge in the beginning of the instruction and their knowledge after the instruction were measured and compared. For the qualitative part, students' reasoning was analyzed at the end of the instruction. The results of this study show that promoting argumentation in a classroom can enhance students' reasoning in science. Reasoning can lead to construction of scientific knowledge. Consequently, there can be significant gains in students' conceptual development by explicating, comparing and challenging ideas.

Eric Eslinger Kathleen Metz

Microcontexts and Practical Epistmology: Problematizing the Constructs of Lesson Enactment and Teacher Knowledge

P-621-1194-1193-1226

Epistemology of science is both crucial to the effective learning of science and a worthwhile learning goal in and of itself. Effectively teaching progressive epistemologies to students requires the use of curricula that engage students in epistemologically rich activities and provide students with opportunities to reflect on the central features of science as a way of knowing. Most existing curricula do not effectively address a progressive epistemology, and studies have shown that teachers do not necessarily modify their existing curricula even if they have the epistemological resources at their disposal to do so. The educational reform literature broadly documents the distance between reform curriculum and the enactment thereof. This article closely examines teacher epistemic beliefs as they take up a reform elementary science curriculum. More specifically, through four strategically selected case studies, it examines the interplay of the teacher's practical epistemology and the values embedded in the curriculum. In analyzing both the teacher talk and the overall lesson structure, it will be made clear that the enacted curriculum is not simply a product of binary 'text beliefs' or 'teacher beliefs' variables, but a rich and layered interplay between the teacher resources and the values embedded in the curriculum.

Rosemary Evans

Investigating the Understanding of Scientific Literacy using Personal Meaning Mapping as an Interview Technique

P-42-1015-1014-1048

International research has indicated that scientific literacy is seen as important for all citizens. Furthermore, curriculum documents indicate that science educators, teachers and researchers believe that scientific literacy is the main purpose of science education in schools world-wide. However, it is also clear that the meaning of scientific literacy is not well understood. This paper reports a qualitative study that investigated understanding of the phrase scientific literacy using Personal Meaning Mapping, an interview-based technique for uncovering people s conceptual ideas. The responses gleaned were sorted to reveal categories which were able to be compared with the attributes of a definition of scientific literacy. The participants were clustered into four groups: elementary school educators; secondary science educators; tertiary science educators; and the general public. This paper reports the parallels and variations among the groups in an attempt to make suggestions on how the enculturation of scientific literacy may be addressed to suit a particular audience.

Susan Everett Gail Luera Charlotte Otto

Assessing Pre-Service Elementary Teacher Growth in Knowledge of Models P-591-1138-1137-1170

We used four different methods in an effort to determine the best means of assessing pre-service elementary teacher growth in knowledge of models and their use in K-8 classrooms. Each method probed a different aspect of models (from growth in scientific use to need for greater emphasis on role and use of model) and each used a different method of gathering student responses (Likert-type responses to concept maps). We determined that growth in knowledge was demonstrated by all instruments but some instruments were more useful than others in the context of our capstone course for pre-service elementary teachers. For example, student ability to use models as scientists do did increase but they remained at the novice level; our senior university students did show improvement in three of the five factors of the SUMS instrument (Treagust, et al, 2002) but this might be expected due to their increased experience with models; the Role of Models in Science (Chittleborough, et al, 2005) also showed an increase in understanding of examples of models and was useful in initiating class discussions; the concept maps showed significant student knowledge improvement in focal areas of the capstone course.

Kathleen FadiganDavid MajerichPenny HammrichIn-Service Teachers Conceptions of Nature of Science:Using the Views on Science and Education (VOSE)QuestionnaireP-640-1302-1301-1333

Nature of Science (NOS) continues to be a topic of great concern for science educators in light of upcoming standardized state science assessments. The purpose of this study is to determine the conceptions of seven NOS aspects as well as attitudes toward teaching the nature of science held by in-service teachers enrolled in a week-long, graduate-level summer course investigating the nature of science and evolution by administering and analyzing the results of Chen s (2006) recently developed Views on Science and Education (VOSE) Questionnaire. In doing so, the study also attempts to evaluate the usefulness of the VOSE instrument for use with in-service teachers. Data include VOSE questionnaire results from prior to the start of the course and two weeks following its completion and from students final project that included integrating NOS aspects into curriculum the teachers already have implemented in the classroom. Results revealed an increase in informed views of the NOS aspects, although the majority of teachers attitudes toward teaching NOS were informed before taking the course.

Chatree FaikhamtaVantipa RoadrangkaJudy MorelandRichard CollA Case Study of a Pre-Service Chemistry Teacher's Pedagogical Content Knowledge Development: From aMethods Course to Field ExperiencesP-64-490-489-526

Pedagogical content knowledge (PCK) has been described as a hallmark of knowledge base for teaching particular subjects. This issue is investigated here by following the journey of Malee (a pseudonym), a Thai pre-service chemistry teacher as she sought to develop PCK during one year of a graduate diploma teaching program. This interpretive case study drew upon classroom observations, semi-structured interviews, surveys and documents as data sources. Data analysis involved an inductive process, categorical aggregation, and a search for correspondence and patterns. The findings indicated that at the beginning of the methods course Malee taught chemistry with little focus on students conceptions. After the intervening methods course, she gradually developed her PCK, which was demonstrated in her teaching when she participated in role modeling and school-based activities. She became more focused on student learning and conceptual development. Factors influencing Malee s PCK development included her teaching experiences, the development of content knowledge, her experiences in the methods course, the cooperating teacher, students, and support from her school and teacher training institution.

Tara FalconeDanielle FordWhere is Science in Preservice Elementary Teachers' Conceptions of Teaching?Q-399-779-778-813

Elementary teachers and teaching tend to be centered on students and caring, while secondary teachers and classrooms are more often content centered. In this study, we analyzed six preservice elementary teachers conceptions of teaching through the lens of identity, in order to explore how (science) content is positioned within their conceptions of teaching. We found that within our participants conceptions, content is a subject-independent medium for caring. We also found that conceptions of teaching range in ways of facilitating caring, which can be viewed along a continuum with teaching as childcare focused on one end, and teaching as content focused on the other. This study supports the notion that views of teaching and teacher identity are strongly related to the age of the students.

Donna Farland William McComas

The Enhanced (E-DAST): A More Valid, Efficient, Reliable & Complete Method of Identifying Students Perceptions of Scientists P-681-1453-1452-1484

The Draw-A-Scientist Test has been used in many research studies since it s development in 1983 by Chambers. The researchers sought to address the reliability of the original DAST by asking 106 third grade students to draw three sequential pictures of scientists in one sitting. Each of the children s three drawings were then analyzed using the DAST Rubric. The students perceptions of scientists were scored specifically in the areas of APPEARANCE, LOCATION, and ACTIVITY. Each category was labeled Sensationalized, Traditional/Naïve or Broader than Traditional. The drawings were then compared to each other. The data collected revealed that students initial drawing was only reinforced and consistent throughout the three categories 24% of the time (or one in four drawings). Leading these researchers to conclude that 76% of the time students hold a range of perceptions, in some cases conflicting perceptions of scientists. Therefore, when children are given the opportunity to draw more than one scientist consecutively they reveal their range of perceptions that may appear to be a more accurate assessment of students perceptions of scientists as opposed to labeling one drawing as many past research studies have done.

Allan FeldmanAllyson Rogan-KlyveKent DivollTranslating experience into practice: the effect of legitimate peripheral participation in authentic science
on classroom practiceP-48-463-462-499

Given the call to improve teachers conceptions of the nature of science (NOS) and to make science teaching more reflective of the way science is actually practiced, this study investigates the impact of legitimate peripheral participation in authentic science on the classroom practice of teachers. Building on previous studies in which changes in teachers scientific content knowledge and conceptions of the NOS were examined, this study focuses on the ways in which teachers can translate this new knowledge into changes in classroom practice. A set of five indicators were developed as a means of understanding the types of changes in classroom practice that result from the teachers research experience, capturing the possible ways the teachers could talk about their experience, and at what level this information could be shared with their students. Our findings indicate that teachers face significant challenges in translating their experiences into practice as they often need to gain or innovate pedagogical content knowledge (PCK) in order to make their experiences usable in the classroom. Implications of the findings for science education and science teacher education are discussed.

Torsten Fischer Peter Reinhold

Patterns of acting - A Reconstruction of two case study examples P-49-1026-1025-1059

In the literature it is reported that new media arrangements enable authentic and situated constructivist teaching methods. From video studies on physics teaching in Germany we know that normal teaching is teacher centred, dominated by the structure of the discipline delivering the content by direct instruction. So, in which way and to what extent do experienced teachers change their patterns of acting (conceptions and reasoning as well as observable scripts) when they (voluntarily) use new media in their teaching. To investigate these changes and differences in the patterns of acting a multi-method case study design is applied. The whole study encompasses 14 teachers (cases), each case consisting of a normal lesson and one using new media from each teacher when introducing a new topic in 11-grade mechanics. In the study quantitative methods are use to get information about the teachers conception of teaching and learning: a standardized questionnaire and a video analysis based on low and high inferent category system (to reconstruct the teaching scripts). In addition, interviews are conducted to provide deeper information about the teachers conceptions and reasoning. The paper presented gives an outline of the theoretical framework, design and research method of the study, describes the applied instruments and reports the results of two cases.

Kathleen Fisher

Semantica Pro Software: A Potential Tool for Educational Researchers P-777-1676-1673-1703

Twenty years ago last June, the SemNet Research Group at the University of California - Davis wrote the first line of code for the SemNet software, a learning tool initially designed for use by biology students. The goal was to create a tool that would help students move along the scale from rote learning to meaningful understanding of ideas. Research has shown that, indeed, when students construct their knowledge in the form of a semantic network, they are able to retrieve and apply that knowledge much more effectively than students, who study in other ways, Semantic networks are powerful in part because they focus one s attention on the specific relation connecting any two pairs of ideas, and it is this connection that represents the essence of meaning. A new company was formed in 2001 to develop and market the SemNet® software. Semantic Research Inc. has developed its successor, Semantica®, now available in version 4.1. Semantica is of considerable interest to the various intelligence agencies involved in fighting the wars on terror and drugs, and they have contributed mightily to the design of the current software. The analyst s tool is both too expensive and too complex for use in the classroom, but many features developed for these agencies could be useful in educational research. I will demonstrate the tool during my presentation and let you be the judge. Below I describe a few of the new features.Perhaps the most exciting feature is natural language processing, the ability to automatically convert text into a semantic network. This field is steadily evolving and gradually becoming more and more useful, although it is still a work in progress. Semantica can also readily convert tabular information into a semantic network and can interface with (read from) a variety of tabular sources. Analysts find that information is much more comprehensible in semantic network than in a table. In fact, simply doing this conversion has been credited with generating some important insights. It is possible to see an overview of an entire network and to extract concept maps from semantic networks, two features that SemNet users often requested. Such tools as templates of relations facilitate network construction. For example, if you want to describe a subject in your study, you may routinely want to know their name, address, age, school, classroom teacher, subject being studied, parents, parents addresses and parents phone numbers. You could create a relation template (see below) to drop on each subject and then fill in the related information, or simply excuse any unused relations.

Michelle FlemingKelly StriffingFrances LawrenzExploring Middle School StudentsAttitudes and Perceptions of Science and ArtQ-534-987-986-1020

Promoting creativity and imagination in K-12 classrooms is a growing area of importance in science education. Although there are an increasing number of curricula featuring science and art activities, there has been little evaluation of their effectiveness. We report here on the impact of a middle school unit incorporating measurement, force, anatomical illustration and the history of science and art on students attitudes and views of science and art. Eighth graders at an urban, public school (N = 75) for gifted and talented students in a large, Midwestern school district participated in the study. General attitudes and perceptions towards science and art were determined using previously researched survey questions and a modified version of the Views of the Nature of Science Questionnaire (VNOS-B version). Follow-up interviews of individual students were conducted to check the validity of the instruments. Classroom observations added relevant information. The integrated unit positively affected student attitudes and perceptions towards science and art, particularly minority students and females. The results were mixed on whether students perceived a relationship between science and art through the explicit use of creativity and imagination in their work. The findings highlight the significance of using artistic activities in science.

Lawrence FlickLeonard CernySpencer HinkleTim CollinsIncreasing High School Student Understanding of the Role of Science and Mathematics for Pursuing
Career GoalsP-290-519-518-555

Students in general education or technical education programs develop the incorrect view that what is learned in high school is not important for their future. They hold this view even as they state that knowing science and mathematics is important for career options they are considering. This report examines data collected from students in general education and construction technology programs focusing specifically on one inner city high school. Data sources were interviews, career efficacy and science and mathematics efficacy and science and mathematics interests. The report also follows a group of twelve students as rising juniors until they graduated who participated in two intensive summer courses that linked construction problems to science and mathematics concepts. Students expressed the importance of mathematics over science as important for technical career options after high school, but can not state examples of how to use their knowledge. A pilot program in the high school and the summer experience produced some improvement in student ability to explicitly discuss science and mathematics applications. Changes in efficacy, interests, career goals, and parental and peer supports are discussed with implications for teaching science.

Lynnae FlynnGlenda CarterEric WiebeSusan ButlerJohn ParkStudent responses to one another:A sequential analysis of small group interactionsQ-411-724-723-758

The purpose of this study was to investigate the interactions which occur between and among individual group members working within small groups using sequential analysis software. Data were collected from an eighth-grade elective class on spatial reasoning, in which six self-selected small groups of three students each worked together throughout the six-week span of the course. Selected videos from one group of three students were transcribed and coded based on student responses to one another and then entered into a sequential analysis program to examine response patterns to individuals within the group. Resulting output was analyzed and indicated that 1) response patterns to individuals within the group differ and, 2) there is continuity in response patterns to individuals during small group work throughout the six week class.

Sufian Forawi

The Upright Pyramid: Is There Room for the Nature of Science at the Early Childhood Level? P-655-1585-1584-1614

Science education practices have historically been guided by what the child did not know, or could not conceptualize. The question of how to produce a scientifically literate population has never been more important than it is in today's world yet a workable answer continues to elude us. The Trends in International Math and Science Studies (TIMSS, 2003) report clearly indicates how poorly the United States is performing in science education (2003). The purpose of this study was to review and analyze literature of the nature of science and identify its impact on early childhood science education in the United States. Rationale for this comprehensive study emphasizes the importance of studying the impact of the nature of science (NOS) and neurology research with preschool and early elementary students. Students are capable of understanding the basic principles of the nature of science (NOS) and would benefit from its inclusion in the early childhood science curriculum. It might look like a very complex yet highly organized assemblage of science facts, processes, theories, practices, experiences, experiments, results, and other aspects of science all bound up with and held firmly by a frame constructed of the concepts that define the NOS. A basic understanding of the NOS and its related practices may be the perfect foundation for a science education model. This study investigated the role of NOS in early childhood education. Results from literature review were presented and analyzed to support a suggested upright early childhood science education model.

Cory ForbesElizabeth DavisBeginning Elementary Teachers' Learning Through the Use of Science Curriculum Materials: ALongitudinal StudyP-234-1178-1177-1210

Beginning elementary teachers face many challenges in learning to teach science. They often lack substantial subject matter knowledge, struggle to articulate scientific inquiry in practice, and often experience teaching contexts in which science is deemphasized or lack resources necessary to support inquiry teaching and learning are lacking. These factors serve to mediate teachers interactions with curriculum materials. It is therefore necessary to learn more about the ways in which new elementary teachers use science curriculum materials and how they learn to do so within this crucial stage of the teacher professional continuum. Three beginning elementary teachers were studied longitudinally over their first three years of professional teaching. Results indicate that they engaged in a substantial degree of curriculum design, drawing on a myriad of curricular resources and modifying them in order to craft localized science curricula. These efforts were influenced, in part, by their own orientations toward science teaching practice but also by features of their unique school contexts. These findings have important implications for our understanding of teacher learning along the teacher professional continuum and help inform research on teachers and teaching, as well as teacher education and science curriculum development.

Vaike Fors

The missing link in learning in science centres P-170-274-273-310

This research sought to investigate teenagers' encounters with science centre exhibits in order to contribute to a better understanding of what role science centres play in the lives of teenagers from an educational point of view. This includes the question of how the exhibits support occurring learning opportunities and how teenagers make use of the displays when they negotiate the meaning in them. It is an in-depth, microanalytical study with a visual ethnographical approach to data collection. The findings are organized in two levels. Firstly, within parameters which indicate how the teenagers participated in the exhibits on one hand, and how they identified them on the other hand. The analysis of data from cross-referencing these parameters provided three classifications of exhibits based on how the teenagers related to the exhibits versus how they dealt with the meaning in the exhibits. Secondly, these results is used to provide insights into how the teenagers want to use the exhibits and what is missing in order for them to do so. Considering teenagers as exponents for what distinguishes today's society, the implications of these findings are interesting to discuss in other learning settings as well.

Samantha Fowler Leila Amiri

Consistency of Moral Sensitivity across Varying Socioscientific Issues P-90-860-859-894

The socioscientific movement calls for the use of socioscientific issues to promote science literacy, enhance the decision-making skills of students, and as a tool for character development. A key component of socioscientific issues are their moral aspects because they allow students to make real-world connections and promote discourse about the topic. Therefore, in order for the use of socioscientific issues to be effective, it is important that students recognize its moral aspect (i.e. have moral sensitivity). The purpose of this study was to determine whether or not a high school student has consistent moral sensitivity for differing types of socioscientific issue scenarios. The high school students in this particular study were consistent in the moral sensitivity displayed for 4 different scenarios. Implications for science education are discussed.

Pamela Fraser-Abder

Achieving Excellence in Urban Science Teaching: Evaluation and Retention P-356-852-851-886

This paper highlights the qualities of excellence in urban science teaching as pinpointed by five urban science teachers who have been actively involved in our professional development and are leaders in the field. Teachers discuss what has worked, what has been challenging, and how their science teaching and learning have evolved in the urban environment. Their responses provide us with a better understanding of how to implement effective professional development, how to support teachers, and how to make more successful urban science classrooms.

Pamela Fraser-Abder

Professional development of science teachers: A global perspective P-784-1690-1687-1717

This seminar will examine professional development of science educators from a variety of perspectives. BouJaoude and Dillon will present the preliminary results of a survey of the readership of science education journals worldwide that aimed to determine the extent to which science educators learn from the experiences of international colleagues. Fraser-Abder will present a global perspective on professional development activities that provide a forum through which teachers can hone their skills, develop, support, and begin to address the specifications of working with their schools . Dillon s contribution will focus on the variation across Europe in terms of science professional development while Hofstein and Mamlok-Naaman will discuss three models of professional development used with Israeli science teachers. Finally, Abd-El-Khalick will focus on professional development for Egyptian teachers by describing two realizations of the Professional growth through engagement model used in large and small scale educational reform projects in Egypt

Pamela Fraser-Abder

Professional Development in an Urban Setting: University, School and Beyond P-356-843-842-877

This paper set describes the work of five science teacher educators who are engaged in urban professional development. Authors describe the professional development model they have used with over 600 science teachers, the impact of their professional development on school practice and policy, their strategies for expanding professional development, the retention of their graduates and the evaluation of the program. The introductory paper describes a professional development model aimed at empowering teachers to identify, and find solutions to the complex educational problems they face in their science classrooms, and to create innovative, effective and culturally relevant science curricula and pedagogy. The model is guided by the notion that all students can learn and achieve when they are supported by a system equipped to deal with their individual needs. The model addresses: creating a common curricula that combines pre-service and in-service teachers working collaboratively to develop a better understanding of urban students, science content and pedagogy; providing teachers with inside the classroom support through an urban science mentor, exposing teachers to recent advances in science, and finally developing on- going networking, school relationships and support systems through monthly professional development meetings, annual conference and a database of inquiry lessons based on the required city science standards. This model has proven to be very successful when implemented in full in both preparing pre-service and in-service teachers and enhancing student achievement.

Tonjua Freeman Regina Suriel Jessie Draper colm Butler

Mary Atwater

Mal-

Sociocultural Issues in Science Education: Preservice, Inservice, and Professional Development P-761-1637-1634-1664

This special symposium, Sociocultural Issues in Science Education: Preservice and Inservice Teacher Education, focuses on the findings of a longitudinal qualitative study that investigates how preservice science teachers plan to accommodate and do implement multicultural education in their science teaching and another study about the assimilationist views of science teachers and their attempts to implement multicultural education into their curriculum units. These two studies expand our understanding of science teacher education and how sociocultural ideas influence the teaching of science which ultimately impacts the quality of science learning in classrooms in the United States.

Kelley Friden Nikki Hanegan

Teaching Practices Representative of Full Immersion and Partially Scaffolded Authentic Inquiry in a Professional Development Comparative Study Q-111-532-531-568

This is a first year examination of a longitudinal study of teaching practices from two professional development programs using mixed methods. The professional development programs consisted of one two-week summer course with follow-up sessions of conference calls and workshops. Program 1 focused on full immersion of authentic inquiry where teachers developed their own research question and implemented a study in the field. Program 2 focused on authentic inquiry as well but used scaffolding pieces that built up to authentic inquiry. Five participants from each program were chosen to be in this comparative study. The mixed-methods research design included qualitative and quantitative data collected from interviews and observations of the ten teacher participants. The analysis indicates that the programs helped teachers successfully incorporate different levels of inquiry and promoted high levels of teacher-student interaction. Two of the three themes that emerged (distinction of questioning levels in both students and teachers and differences in cognitive activities) were found to be statistically significant between the two programs. These themes showed that students of Program 1 participants asked more open-ended questions and were performing at a different cognitive level. This increase of open-ended questioning skills and cognitive levels can be attributed to the full immersion of authentic processes the teachers went through in the Program 1 professional development program.

Melina Furman Angela Calabrese Barton

Using transformative action research as a tool for learning to teach science in urban schools P-557-1047-1046-1080

The high level of teacher attrition, especially in high poverty urban schools, is one of the most important problems presently faced by American education. Providing a specialized teacher preparation has been proposed by many as a way to overcome urban teacher early burnout and increase teacher retention. In this study we conducted case studies of four preservice teachers participating in the Urban Science Education Fellows Program at Teachers College. This program aimed to prepare teachers with the vision and skills to teach science in urban settings under a vision of social justice. Over the year, preservice teachers partnered with middle school science teachers to develop a transformative action research project based on authentic classroom needs. We found that engaging in transformative action research supported preservice teachers in developing a deeper understanding of the realities of urban schools and urban children, as well as building a sense of agency grounded on an authentic experience of bringing about change to an urban classroom. We finally discuss the potential of transformative action research as a tool for urban science teacher education.

Melina Furman Angela Calabrese Barton Nicholas Stroud Beverly Lafferty Transformative Action Pasagraph in Unban Science Education

Jennie Brotman

Purvi Vora

Transformative Action Research in Urban Science Education P-557-1299-1298-1330

In this session we present a set of transformative action research (TAR) studies conducted in middle schools in New York City. TAR builds on the methodology of action research by aiming to cocreate a transformation based on the needs of an educational setting wiht the authentic participation of those involved in it. As part of our work at the Urban Science Education Center at Teachers College, for the past 5 years we have used a TAR methodology to co- author spaces for research and innovation in partner middle schools located in high poverty urban areas. In doing so, we have focused on TAR as a pedagogical tool to prepare science teachers to teach science in urban schools. We have also used TAR as a way to collaboratively transform science teacher's practice and create new forms of participation in school science for urban children. We report our findings for six TAR studies that look across these 3 aspects of urban education: preservice teacher learning, teacher professional development and student learning. Looking across the studies, we discuss the potential of TAR as a fundamental educational research approach in high poverty communities, as it allows researchers to partner with school participants to coauthor new teaching and learning opportunities.

Mark GagnonSandra AbellThe NARST AcademicGenealogy ProjectP-400-703-702-737

An Academic Genealogy traces the line of descent of a person's intellectual development, using their highest non-honorary PhD or EdD degree as the focal point of lineage. The NARST Academic Genealogy Project looks at the historical development and trends in science education with a focus on one's academic genealogy. This approach is a new perspective in science education, but has been used in various STEM fields. We distributed a questionnaire at the NARST 2006 Conference and on the NARST listserv. We used data from 157 questionnaires responses to create lineages of NARST members; we solicited additional information from NARST members and the Internet to create more robust lineages. Using Excel and a genealogy software program, Heredis Mac X. 2, we found two patterns in the data. The first pattern is related to hotshots, individuals who have advised a large number of science education doctoral students. The second pattern in the data related to hotspots--university locations and time periods that produced a large number of doctoral graduates. Although there are limitations in the genealogies constructed due to the responses received, NARST members can trace the influence of hotshots and hotspots as they and their progeny impact science education.

Estelle Gaigher

Teacher Response to Learner Questions in Science Classrooms P-597-1136-1135-1168

This paper explores how teacher response to learner questions can provide opportunities for learning through discourse in science classrooms. The study is part of an ongoing action research project aimed at developing response skills of pre-service science teachers. Five response categories were identified by a group of twelve pre-service teachers before they started data collection during a four-month teaching apprenticeship in twelve middleclass schools. Voice recordings were made of six lessons taught by each mentor teacher and six lessons taught by each pre-service teachers. Relevant parts of the recordings were transcribed to study the responses to learners' cognitive questions. Teachers' responses were classified and compared to transcriptions, this showed that responses were mostly factual answers, without further classroom discussion. During the apprenticeship, the pre- service teachers reflected on their own responses and each developed, implemented and evaluated a plan to improve his/her own response skills. This paper and the ongoing project will contribute to understanding a largely neglected side of classroom questioning and answering, namely how teachers respond to learner questions.

Jodie Galosy

Trouble with Activities: Novice Science Teachers and Hands-on Science in Urban Classrooms P-726-1511-1510-1541

Secondary science teacher education promotes hands-on classroom activities as one way of enhancing student engagement with science. However, we know little about the support required to help early career science teachers maximize the intellectual potential of hands-on work. This paper investigates what six novice middle/high school science teachers learned about using hands-on activities in their urban classrooms. Study participants all reported difficulties engaging students with content. They also seemed convinced that activities held promise for motivating students. However, the novices had considerable difficulty enacting hands-on science with their students. Most teachers developed an approach that mimicked their textbooks activities were sidebars or add-ons, not essential for learning. Personal and workplace resources enhanced or impeded their efforts, shaping how teachers used activities in their classrooms. While all of novices had access to supplies and logistical support from induction or professional development programs (primarily from outside their schools), few had opportunities that seemed most promising for using activities as tools for intellectual engagement context-specific assistance where student learning goals, rather than the activities themselves, were the focal point. Coordinating induction with professional development programs, prioritizing context-specific support, and respecting time demands would likely benefit new science teachers and their students.

Peter Garik Andrew Duffy Arthur Eisenkraft Russell Faux Luciana Garbayo Tiffany-Rose Sikorski

Improving the Teaching of Physics: Professional Development for Teachers Changing Content Fields Q-570-1396-1395-1427

The School of Education and the Department of Physics at an urban research university are offering a sequence of courses for teachers of physics who do not have a content background in the field. The objective is to prepare these teachers so that they (1) have mastered the basic concepts of physics; (2) are comfortable with experimental equipment; (3) are familiar with the conceptual history of physics; (4) are familiar with the physics education research literature; (5) participate in a physics community; and, (6) develop their physics pedagogical content knowledge. Using self-reporting surveys and concept inventories, the study is following the progress of the participants as they develop confidence in their understanding of physics, and the associated pedagogy. The self-reports indicate improvement in participants' use of the material in the courses. The respondents refer to greater confidence in their problem-solving ability, their understanding of physics education research literature in thinking about their teaching. Objective results from test results also indicate improved content knowledge.

Andoni GarritzKira PadillaAna Ponce-de-LeonFlorencia RembadoThe Pedagogical Content Knowledge of Latin-American chemistry professors on the magnitude amount of
substance and its unit moleP-385-677-676-711

This paper documents PCK of the topic amount of substance' for a set of four university professors of General Chemistry, following Loughran et al's methodology of the Content Representation (CoRe) and the Professional and Pedagogical experience Repertoires (PaP-eRs). In three steps, the CoRes were connected with the structure of knowledge of the professors by means of Mortimer's conceptual profile concept: Firstly, the central ideas related with the teaching of amount of substance', one of the fundamental magnitudes of the International System of Units (SI), were selected by consensus among the professors interviewed, so the analysis could be made with only one set of central ideas. Secondly, a set of five conceptual profile zones were defined, following the characteristics proposed by Mortimer: perceptive/intuitive, empiricist, formalist, rationalist and formal rationalist. Thirdly, these zones were used to classify each one of the sentences given by each professor in the CoRe questionnaire from which a conceptual profile graphic was constructed. These conceptual profile graphics represent the epistemological and ontological commitments of individual teachers, an enlightening way of classifying the professors' knowledge base, from which their teaching characteristics will be analyzed and discussed.
Anne GatlingDean AndersonMeredith HouleMichael BarnettPreparing Elementary Teachers to Teach Science in Urban Elementary Schools:The Impact of IntensiveField Experiences, Curriculum Implementation, and BeliefsP-611-1168-1167-1200

We have redesigned our elementary science methods courses to include pro- longed opportunities for our pre-service teachers to interact, evaluate, modify and enact reform-based curriculum materials with ethnically and linguistically diverse urban students. Namely, we wished to provide a focused, supportive field experience for our pre-service teachers, provide them with the opportunity to modify and enact curriculum materials for a diverse set of students, support critical reflection upon their existing beliefs regarding urban students, and experience what it means to be a teacher of science. In this paper we report on the impact of a redesigned elementary science methods course on pre-service teachers' preparation to teach science, teach in urban settings, and to modify and enact curriculum materials.

Andrea Gay

Impact of pedagogical contexts on K-8 teachers perseverance learning chemistry in a professional development course P-347-1409-1408-1440

In innovative science content courses for teachers, concepts are often situated in pedagogical contexts, drawing explicit connections to teaching and student learning in order to facilitate transfer to the classroom. This study examines how pedagogical contexts can also impact teacher engagement and chemistry content learning in a professional development (PD) class. The course, Matter and Energy for K-8 in-service teachers, was investigated using a case study methodology. Data was collected from teacher journals, participant/observer field notes, teacher interviews, and videotapes of class sessions. Findings indicate that pedagogical contexts allow teachers to view the PD classroom from the eyes of both a student and a teacher. Identifying with their PD instructors, teachers can appreciate PD pedagogies and activities, which can propel them to persist as students in learning chemistry concepts despite difficulties or frustrations. Identifying with their students and viewing the similarities between their own learning and their students' learning can similarly compel teachers to continue grappling with challenging concepts. Incorporation of pedagogical contexts in professional development can encourage persistence in learning chemistry, which potentially can lead to greater science content learning by teachers.

Yun-Ping Ge Chen-Chi Lu

Between Ideals and Outcomes: A Local Survey of Science Teachers Reflections on Taiwanese Curriculum Reform P-320-1219-1218-1251

With the sociological indication that science conflicts Chinese learning culture, this 3-year longitudinal study intended to investigate what Taiwanese elementary science teacher reflections were in the face of Grade 1-9 curriculum reform. It expected to provide an important reference to the further policy making and research. The methodology adopted interviews and classroom observations to get deeper insight of the most concerned issues, attitudes, and implementation of the teachers towards the new curriculum. The analysis revealed that all the reflections primarily focused on 5 categories: Teaching practice, assessment, facilities or resources, curriculum goals, and policy making. Most of the attitudes towards this reform were neutral. Only very few of them had positively appreciated the reform. However, among the negative attitudes, most of the reflections were to criticize the organization of curriculum and structure of the textbooks. The demand of high scores from parents, the culture conflicts between new curriculum and classroom culture imposed tremendous impediment on the implementation. These inhibited the teachers to see the merits of integrated curriculum in problem solving and scientific literacy, which were once the benchmark foci, now remained only slogans. Implications and suggestions for teacher education were made.

Uric Geer David Rudge

Pedagogic Revision and a College Science Instructor: Impacting Views of Teaching and Learning. P-337-952-951-985

This paper presents a case study of a large lecture university chemistry instructor who participated in a large NSF sponsored grant, Enlist, Equip and Empower (E3): A Program for the Preparation of Middle School Teachers at a large public university within the Midwest. The instructor was invited to revise his traditionally taught course in ways that would make it more student-centered and inquiry based over the course of a year. The paper discusses how and to what extent his views of teaching and learning were affected by his participation, with reference to both self-reported data and observations of his teaching throughout his involvement on the project. Two central questions guided this study: 1) Will guided pedagogic revision during the course of the project affect his views of teaching and learning?, and, 2) If so, what qualitatively described aspects of change can be noted throughout the pedagogic revision process?

Lara Gengarelly Eleanor Abrams

Karen Graham

Enhancing the Level of Inquiry in the Science Classroom P-657-1315-1314-1346

Teaching students how to conduct authentic scientific inquiry is an essential aspect of recent reform efforts in science education. The National Science Foundation has funded a program, Graduate Teaching Fellows in K-12 Initiative (GK-12), in which graduate students in the sciences collaborate with secondary school science and math teachers in order to enhance inquiry-based instruction in K-12 classrooms. This research was a follow-up study that examined the changes in graduate Fellows' conception of their own inquiry and inquiry in the classroom while they participated in the second year of a GK-12 program organized by our university. Qualitative data in the form of interviews were collected from graduate Fellows for one academic year. Similar to our previous study the Fellows' conception of inquiry in the classroom changed from a responsive and inquisitive student to a student who conducts an authentic inquiry- based research project. In addition, the partner teachers' open-mindedness toward inquiry influenced the level of inquiry enacted in the classroom. Despite the constraints of the school culture, including the teachers' attitudes, Fellows acted as agents of change. The graduate Fellow and high school teacher partnership is an effective professional development model to create positive and lasting change within science classrooms.

Penny Gilmer Jennifer Cirillo

Using cogenerative dialogue with undergraduate biochemistry students to improve learning environment *P*-273-1618-1617-1647

This is a study on effect of cogenerative dialogue in an undergraduate biochemistry class. The instructor meets with four students once a week, and allows students to talks out ideas for improvement, which can be implemented the following class periods. The instructor gets feedback right away. Other students not in the cogen group have an opportunity for providing feedback through the class Web site. This is a formative assessment of the learning environment. The instructor uses transcripts and sorts the data, looking for themes, focusing on the contradictions, so that she can get to the issues that could be discussed.

Karen Givvin Meike Lemmens Rossella Santagata

Assessing Learning in Preservice and Inservice Teacher Education: Preliminary Results of the ViSTA and STELLA Programs

P-396-1447-1446-1478

The first paper in this series asks the questions: How can video technology best support teacher learning from analysis of videocases? And what kinds of teacher learning are best supported by videocase-based programs? As a follow-up, the present paper asks the question: How can we know? We describe how teacher and student learning is being assessed within two on-line, video-based programs designed for teachers. We present several constructs the programs set out to assess (i.e., teacher content knowledge, PCK, teaching practice, and student learning) and describe the measures being used to assess them. We share also some of the methods we are using to employ those measures as well as early findings that have resulted from their use. It is our hope that some of the innovative methods and combinations of assessments used by the projects will stimulate debate and critique. The result can then be improvement of teacher learning programs guided by trusted evidence

Howard Glasser

Gender's (not Sex's) Impact in a Science Classroom and on Students' Performance P-496-1009-1008-1042

Studies have reported that males participate in, succeed in, and enjoy physics more than females. These papers categorize students by biological sex, often ignoring within-sex variability. This study aimed to conceptually define and operationalize gender to examine how this construct impacted students' in-class performance, by exploring how the students and teacher in a junior high school physical science classroom context talked about gender, and how the environment, instruction/activities, and student/teacher behaviors may have influenced these comments and students' performance. The teacher's comments implied that academic performance was positively related to the students' maturity level and behaviors. Girls, whom she viewed as more mature and better behaved than the boys, outperformed boys in her class. Among the boys, those who exhibited 'girl-like ' maturity and quietness outperformed boys who exhibited 'boy-like' immaturity and questioned and challenged content and instructions. Additionally, the teacher's comments about the nature of school science implied that the supposedly girl-like behavior of quiet acceptance of content was highly valued in her class. This study argues for the importance of more 'gender-aware' classrooms and warns against generalized 'one size fits all' policies given the importance of assessing contextual factors in affecting school-related outcomes in science class.

George Glasson Absalom Phiri Ndalapa Mhango

Indigenous Science Educcation in Africa P-642-1305-1304-1336

Researchers investigated how indigenous science knowledge can enhance the learning of Western science and teaching about ecological sustainability issues in developing African countries. Data sources included interviews with traditional healers and elders in Malawi to learn about indigenous science practices, interviews with Malawian teachers to assess their understandings and use of indigenous science in the curriculum, and science curriculum guides that pertain to the use of indigenous science. These interviews and data analysis revealed that traditional healers and elders were able to identify many common applications of indigenous knowledge. African educators were also very aware of traditional beliefs and practices; however, the acquisition and application of indigenous science was marginalized as not being acceptable science. From the analysis of curriculum guides, most examples of indigenous knowledge were portrayed negatively as examples of non- science. The researchers concluded that Western science knowledge becomes more meaningful when it is not compartmentalized and taught as a subject separate from the culture and environment where the children live.

Ina Glemnitz Elke Sumfleth

The Influence of the Process of Vertical Linkage in different Instructional Approaches on the Performance of Students P-587-1122-1121-1155

Bad results in large scale assessments of German lower secondary students in science education increased the demand for enhancing vertical linkage in instruction. Because very little is known about the construct of vertical linkage itself and its impact on teaching and learning a 'model of vertical linkage' is introduced in this paper. Furthermore, within the different attempts to enhance vertical linkage worldwide, context-based approaches to teaching gained some importance lately. Therefore, a comparison study between high and low linking traditionally instructed classes and classes instructed through the German approach 'Chemie im Kontext' (ChiK) is described. Video analysis and performance tests have been carried out in order to relate linkage within instructional learning processes with learning outcomes. It is shown via video-analysis that the rank of ChiK- classes is in line with high linking classes looking at the level of vertical linkage on students side and lower on teacher side. They rank higher on both sides than low linking classes the level of the teacher is higher than the level of students. The performance in ChiK-classes is better than in all other classes.

Arhonda Gogos George DeBoer

Assessing students' understanding of 'controlling variables' Q-333-571-570-607

It is well known that when faced with questions about controlling variables (CV), students often invoke ideas about the physical situation being described rather than drawing on the idea that only one variable should vary while all others are kept constant. The study that is reported here examines the effectiveness of multiple-choice test items in assessing students' understanding of controlling variables and confirms this well documented tendency for students to use what they think they know about a situation when answering these questions. We observed this tendency not only in students who seem to have little if any understanding of CV, but also in students whose responses suggest that their knowledge of CV is relatively secure. We also examine whether different contexts have an effect on students' tendency to invoke their ideas about that context. This work is part of a larger project to develop standards-based distractor-driven multiple-choice assessment items and has implications for how to test students' understanding of CV and how much confidence we can have in the results of testing in this area.

Daphne GoldmanBella YavetzSara Pe'erRelationship between Environmental Literacy and Background Characteristics of Beginner Teacher-
Training Students - Implications for Training ProgramsP-430-1042-1041-1075

Relationship between Environmental Literacy and Background Characteristics of Beginner Teacher-Training Students - Implications for Training Programs Goldman, D., Beit Berl Academic College, Kfar-Sava, Israel Yavetz, B., Kibbutzim College of Education, Tel-Aviv, Israel Pe'er, S. Oranim Academic College of Education, Tivon, Israel A major challenge facing environmental education is to strengthen the environmental literacy component of pre- service teachers' programs. This study aimed to characterize the level of environmental literacy of beginner students in teacher training colleges and investigate the relationship between these variables and background factors. The study was conducted by a questionnaire administered to 765 students from three major teacher training colleges in Israel. Major results: Students' environmental knowledge is very limited. The students maintain overall positive attitudes towards the environment but they don't translate these positive attitudes into responsible environmental behavior. The environmental knowledge of Arab students is even lower than that of Jewish students and their environmental attitudes are less positive, but the two groups did not significantly differ in their reported behavior. A positive relationship was found between students' attitudes and level of knowledge and the extent of their mothers' education but no difference was found in reported behavior. Students who chose to major in environmentally-related subjects scored higher in all the environmental literacy variables as compared to those who chose non-environmentally-related subjects. This up-to- date profile of the environmental literacy of teacher- training students is one prerequisite to ascertain how environmental education, as a tool for developing environmental literacy, might better be incorporated into their professional training.

M. Jenice Goldston Joy Jones

Exploring Community and Science: A View of Cultural Relevancy in Science through the Photo eyes of Middle Level Students P-80-1558-1557-1587

The purpose of this study is to examine a teacher's and her middle school students' views of science within their predominantly Black community. Students used the digital photographs to capture and explain their views of how science is infused in their neighborhood and community. Complementing the students photos, are narrative compositions explaining their choices and connections. As students presented photostories, the class began to envision cultural relevancy in science for themselves and their classroom. The research, guided by three questions included: 1) How do students engage their memories and experiences of science as they select and create a digital photostories of science in the community? 2) In what ways do photostories serve as referents for revealing middle school students science identity narratives? and; 3) What photostory referent identify/clarify disconnects to school science that are important toward envisioning cultural relevancy in their classroom? Anchored within sociocultural theory, visual methodology, and narrative inquiry the study hones in upon individual and collective understandings while recognizing the assumption that constructs of science identities as narratives are socioculturally constituted (Sfard & Prusak 2005; Wertsch, 1998). Initial themes suggest 1) Digital photostories provided a innovation authoring space for students to begin to draw out their images of science and examine them in light of their views of science in the community, and 2) Digital photostory narratives reveal connections and disjunctures between students prior science experiences and their images of science as a community practice.

Susan Gomez-Zwiep

Elementary Teachers' Understanding of Students' Prior Knowledge: Implications for Practice and Teacher Education P-126-951-950-984

This descriptive study sought to determine elementary teachers' level of understanding related to student misconceptions and instruction. The sample included thirty teachers from California with at least one-year experience teaching grades 3, 4, and/or 5. A semi-structured interview was used. The interview transcripts were transcribed and coded under the following categories: definition of misconceptions, sources of misconceptions, development of misconceptions and teaching strategies for addressing misconceptions. The results suggest that although most of the teachers are aware of misconceptions they do not have a complete understanding of the nature of misconceptions. The teachers in this study did not see their science instruction as a method of refining and transforming students' misconceptions, even though the majority of teachers were aware they exist. Implications for pre-service teacher education and teacher professional development are discussed.

Elizabeth Gonzalez

Barbara Hug

Middle School Science Curriculum: How Classroom Practices Inform Curriculum Design P-583-1212-1211-1244

A key challenge for improving the impact and use of curriculum materials on the classroom is for the designers to consider the central role teachers have in the curriculum implementation. In this research we proposed curriculum design strategies that support in-depth understanding of genetics concepts and scientific processes specified in national science education standards and Illinois State Standards while taking into consideration the teachers' role and uses of the materials. The goal was to illustrate how curriculum enactments informed and influenced on the design and revision of curriculum materials. The researchers developed a 6-week genetic unit; three middle science teachers participated in two piloting tests. Based on classroom observations, field notes, and teachers' interviews, we identified areas of strengths and weaknesses in the enactment and curriculum materials. Our analysis revealed different challenges related to decisions about goals and content standards intended to address, students' cognitive understanding in genetics, and issues specific to the implementation of the unit and teachers' perceptions of it. These dilemmas shaped the activities proposed and teaching strategies used. In order to solve these issues we included the use of tangrams as an enriched analogy for teaching about traits and inheritance.

Sheraton New Orleans Hotel • New Orleans, LA

Ron GoodJames ShymanskyLarry YoreMichael VitaleNancy RomancePresidential-sponsored Symposium: A Critical Look at ScienceEducation as a Field of ResearchS-776-1674-1671-1701

In his presidential address at the 2006 NARST meeting in San Francisco, Jim Shymansky raised questions about the extent to which science teachers, scientists, and others concerned with science education pay attention to the research being presented and published by the science education research community. This symposium is a follow-up to that address. How effective are we in the science education research community at building the research base of science education and adding knowledge to it? Do science teachers, teachers of science teachers, policy makers, or even others involved in science education research really building on the papers presented at our meetings and published in our journal? Are there things we do and say in those papers and publications that reduce our effectiveness? How might we improve the ways we conduct and communicate our research? Should NARST (or some organization or body) prioritize the various research agendas in science education? How should this be done? Is the field of science education research progressive and cumulative in nature, as in the natural sciences, or merely an accumulation of seemingly random publications? What are some trends in recent science education research and what implications do they have for science education as a research discipline? These are among the questions that will be asked and discussed in this symposium. A past editor of JRST will moderate the session. It will follow a format similar to the popular television program, 'Meet the Press,' with the slight modification that the final 15 minutes of the session will be open for questions and comments by audience members.

Julie Grady David Lally Erin Dolan

Scientific Inquiry in High School Science and Agriculture Classes: Opportunities for Students to Enrich their Conceptions of the Nature of Science Q-183-298-297-334

The purpose of this study was to explore to what degree and how students had opportunities to strengthen their conceptions of the nature of science during scientific inquiry. Two biology teachers and one agriculture teacher and their students, from three different schools and communities participated in the study. The context of the students' inquiries, the Partnership for Research and Education in Plants (PREP), provided students with opportunities to design and conduct original, long-term experiments to determine the unknown functions of genes knocked-out of plants by scientists. Teachers' interviews were analyzed for their interests in and goals for bringing the PREP experience into their classrooms. Student group interviews were conducted to obtain students' views of their inquiry experience. Classroom observations, documents, and student work contributed to explicating students' involvement in scientific inquiry. A preliminary analysis of interviews, observations, and documents indicates that, in spite of the students were involved with few activities, discussions, or reflections that explicitly challenged their conceptions of the nature of science. Exceptions occurred when scientists visited the students to talk with them about designing and conducting their experiments.

Andre' Green George Glasson Brenda Brand

Factors Influencing The Persistence And Non-Persistence Of African American Students In Scientific Majors At A Predominantly White University Q-322-592-591-628

Factors that influenced African Americans to persist or not persist within their scientific major while matriculating at a predominantly White university guided the focus of this study. The study explored the perceptions of African Americans that were both persistent and non-persistent within with their scientific major in order to gain a better understanding of what steps could be taken for the retention and encouragement of more African Americans in these fields at a predominantly White university. The study explored other factors besides intelligence that inhibited or promoted the success of African Americans in scientific fields. The study was qualitative in nature and participant interviews provided the data for the study. Actor network theory was used as a theoretical framework for exploring the factors that caused students to persist or not persist within a scientific major with the major implications of the study being: (1) The persistence of students had more to do with the open and closed networks they participated in rather than their intellect; (2) The student development of networks aligned with their ability to overcome the negative images associated with them in science; (3) Students' development of closed networks were a means of protection.

Kelly Grindstaff

Determining Discourses: Resources and constraints influencing early career science teachers P-735-1549-1548-1579

This study looks holistically at early career science teachers' thinking and action by paying close attention to the different contexts, with varying resources and constraints, within which they work. I investigate how five early career science teachers conceptualize science literacy, how they go about trying to achieve science literacy for all of their particular students and what they feel enables and constraints them in doing so. Two teachers are in a mixed socioeconomic urban setting, and three teach in an affluent suburb in a large western Canadian metropolitan setting. The ideas of science literacy vary depending mostly on teachers' previous experiences and beliefs. However, enactment of curriculum depends as much on the culture of schools, with growing emphasis on accounting and accountability, as well as teachers' relationships with and views of students. Curriculum, pedagogy and relationships with students were not appreciably different between the urban and suburban settings. And all teachers felt similar constraints in terms of time to prepare and time for support from more experienced teachers, though all felt that the latter was significantly helpful when they could get it. This suggests as much attention be paid to teachers' relationships with students and the culture of individual schools and schooling as to teachers knowledge and beliefs about science. And, as other studies suggest, new teachers need more time and more opportunities for true mentoring to help them develop practices that include thinking about and working toward achieving science literacy for all.

Meghan Groome

Factors that Influence Question Rejection in Two Urban Middle School Science Classrooms P-473-858-857-892

Teachers create the norms and rules in their classroom and they change and evolve as the class continues. If we position the classroom as a Community of Practice, that we must consider that students are also a part of this process and this intersection of teacher rules and student resistance and compliance will determine at any time what the norms and values of that classroom are. In this presentation, two case studies of middle school teachers will be presented to examine the rigidity of their classroom rules in regards to student questioning opportunities. One teacher is considered a very strict teacher who prides himself on classroom management while the other teacher prides herself on her student's expression and enthusiasm as a result of her relaxed approach to classroom management. As a counter part to this study, specific classroom events will be examined to detail the process of student resistance and rule evolution. Results indicate that three variables influence a teacher's rejection of questions: the amount of time available for instruction, who asks the question, and the topic of the question in relation to the topic of the lesson. While some of these factors can be mitigated through professional development around lesson design and unit planning, the results also reveal that both teacher reject girls' questions more frequently than boys' questions suggestion that professional development around gender inequity are also necessary.

Crissie Grove Patricia Dixon

Research Experiences for Teachers: Implications for Science Teachers' Planning and Reflection P-258-472-471-508

This qualitative study examines one professional development program and how this experience affects teachers' reflective planning and their enactment of those plans (Loucks-Horsley et al, 2003). The Research Experiences for Teachers (RET) program allows fifteen K-12 science teachers, selected from across the nation, to spend six weeks with a mentor scientist in a nationally recognized science laboratory. Program features are specifically designed to encourage reflective planning based on teachers' understanding of inquiry, experimental design, the nature of science, process skills and communication. This study investigated the quality and effectiveness of teachers' planning and reflection in science both at the start and end of the RET program. Features of the RET program are designed to encourage more reflective science teaching. Reflective teachers give consideration to the voices and opinions of the students, and contemplate the consequences of lessons and activities for their students (Valli, 1997). NARST members will be interested in the findings concerning this professional development experience and how this impacted science teachers and needs for additional studies on this and other professional development programs. Results from a previous study suggested the following research question: What features of an RET program affect teachers' reflective planning and implementation of plans?

David Grueber

Revealing Tensions between Curriculum Goals and Classroom Norms P-589-1120-1119-1153

Curriculum materials sometimes require teachers to enact new social roles associated with norms of scientific inquiry practices. Curriculum materials designed to include an emphasis on scientific inquiry give teachers the responsibility of making sure that a priority is given to evidence. A priority on evidence requires teachers and students to learn new social roles in the classroom. This leads to the following research question, what social roles, rights, and responsibilities do teachers assume when leading discussions about phenomena with a reform based curriculum? Four teachers enacted the IQWST curriculum in three schools. Data sources included video and audio recordings and transcriptions of discourse. The techniques of conversation analysis permit a detailed study of patterns in interaction which implicate certain identities, roles and/or relationships of the participants. In general, analyses across the four classrooms show a continuing tension between the goals of IQWST and the structure of classroom conversations. The traditional structure of classroom talk places the teacher in a position of both intellectual and social authority. Shifting to a mode of classroom discussion where the teacher maintains social control while intellectual authority shifts to students' discussion and interpretation of evidence is a complex process that the teachers accomplished only rarely.

Kristin GunckelMin-Jung BaeEdward SmithUsing Instructional Models to Promote EffectiveUse of Curriculum Materials among PreserviceElementary TeachersP-234-1175-1174-1207

Preparing elementary preservice teachers to use curriculum materials critically in planning and teaching inquiry-oriented science lessons is an important challenge for teacher educators. Analyzing the affordances and constraints of curriculum materials and appropriately modifying materials to develop inquiry- oriented lesson plans are important teacher practices. Yet, new teachers often follow curriculum materials uncritically and do not recognize curriculum materials analysis and modification as authentic tasks of teaching. This paper examines the effectiveness of using instructional models to support pre-service teachers' critical use of curriculum materials in developing inquiry-based lessons. Findings suggest that preservice teachers find instructional models helpful in guiding lesson planning, but that they often struggle to understand and integrate multiple frameworks. Furthermore, they do not use the models to guide curriculum materials analysis. We conclude by presenting a new Inquiry and Application Analysis and Planning Model that synthesizes features of many instructional models into a single, coherent framework and incorporates curriculum materials analysis criteria in its use. This work informs the design of teacher education activities that support preservice teachers in learning to critically analyze and modify existing materials to produce inquiry-oriented lessons.

NARST Annual International Conference 2007

Murat Gunel

Investigating the impact of teachers implementation practices on academic achievement in science during a long-term professional development program *P*-83-146-145-182

This study is a part of a bigger project known as the Science Writing Heuristic (SWH) Partnership Professional Development Project, conducted at the two local universities in association with the State Department of Education to help improve science teaching. Overall, the goal of the project is to help practicing science teachers understand and apply a student-oriented instructional approach, using the SWH. The purpose of this research study was to examine the link between teachers' implementation of a student-oriented teaching approach through the SWH approach with embedded non-traditional writing practices and students' performances on standardized tests over a 3-year period. This study investigated the impact of 6 teachers' implementation of the SWH approach on student standardized test scores over the 3-year period. A mixed method approach was adopted as a research method. Results of the study indicated a differential across teachers in terms of improvement in pedagogical skills related to the SWH approach. Also, results showed that the SWH approach in-service program did have an impact on participating teachers' pedagogical practices. The majority of the participating teachers improved their pedagogical practices of implementing science inquiry through the SWH approach over the 3-year period of the professional development program. Further, when teachers' rankings were correlated against students' standardized test scores, the results indicated that as their implementation levels increased their students' test achievements also increased.

Esme HacieminogluOzgul YilmazHamide ErtepinarExploring Relationships among StudentsLearning Approach, Motivational Goals, and AchievementP-329-566-565-602

The purposes of this study were to investigate the relationship among students' learning approach, motivational goals, previous semester science grades and their achievement in atom and periodic table concepts and explore how well do the learning approach, motivational goal and students' previous semester science grades predict students' achievement. The surveys of this study were administered to 416 students enrolled in seventh grade elementary schools located in Ankara, Turkey. Correlational analysis was run to determine the relationships among students' learning approach, motivational goal and achievement, then multiple regression analysis was conducted to better understand how the predictor variables might be associated with students' achievement,. Chemistry Achievement Test, Learning Approach Questionnaire, Achievement Motivation Questionnaire were administered. Results showed that; meaningful learning, performance orientation and self efficacy were positively correlated with learning orientation. While students' previous semester science grades were positively correlated with achievement, meaningful learning, and self- efficacy, it was negatively correlated with self efficacy. Moreover, there was a positive relationship between rote learning and performance orientation. Multiple regression analyses indicated that rote learning and students' previous semester science grades were contributed to the students' achievement.

Rita HagevikMary WatsonBoger DavidPowers LarryContent Mentoring and ItsImpact on Middle Grades Mathematics and Science Teacher EffectivenessQ-546-1014-1013-1047

This study investigates the impact of content mentoring by University STEM professionals on middle school science and mathematics teachers' 1) knowledge, 2) skills, 3) dispositions, and 4) their overall ability to effectively facilitate student learning and achievement. This research address critical national, state and local issues concerning recruitment, preparation, induction, retention and continued development of middle grades mathematics and science teachers. Subjects for this research includes 144 middle school teachers (grades 6-8) from five counties and University STEM content mentors with Ph.D. degrees in mathematics and science fields. Data on student learning from 72 randomly selected teachers for both the control and experimental groups who agree to participate in the study include student end of year test and achievement scores. Quantitative data from teachers include teacher end of year assessments and Praxis II mathematics or science tests for the middle grades. Qualitative data collected from individual observations and conversations. Initial findings indicate that University mentors and their teachers are gaining a deeper understanding of each others field of study which will affect student content learning in the classroom.

Penny Hammrich	Michelle Myers	Kathy Fadigan
Sonia Rodrigues	Michelle Ariano	Beata Breg
Sisters in Science in the Community	V	
P-84-386-385-422		

The overall goal of the Sisters in Science in the Community (SISCOM) project is to replicate the Sisters in Sport Science program, which is the most innovative and successful programs of the Sisters in Science Equity Reform project, in area community based organizations. Utilizing sports as a vehicle for learning, girls gain a better understanding of the underlying principles of science and mathematics embedded in the mechanics of performing a sport. SISCOM is an informal science enrichment program that addresses the need for urban girls to gain equitable access to science education in a non- competitive and academically non-threatening community/family setting.

Jeong-woo Son

JaeYoung Han	Jung Hoon Choi	Young-Joon Shin		
JeongHo Cha	Bookkee Hwang			
Three Relationships between Gesture and Language in Science Exploration				
Q-577-1105-1104-113	88			

The communications among people include both gesture (non- verbal component) and language (verbal component). The gesture one person use can convey more important meaning than his/her language. For example, a man can say to his girl friend 'I love you' while he is looking another woman: then, he might want to say 'I don't love you any more.' Thus, we should focus both on the gesture and on the language to unveil the communication process. In this study, we investigated the gesture and language observed in a science exploration activity. This study presents fine-grained analyses of videotaped fragment of interactions among participants in a science festival held by 'Teachers for Exciting Science' in Korea. Three cases of interplay between gesture and language were found as follows. First, the gesture assisted the language in the explanation. For example, the gesture shows an example of what the language says. Second, the gesture has an essential role over the language. For example, the speaker says 'the right angle' while he shows the specific angle with his arms. Third, the gesture is contradictory to the language. This study suggests that more focus should be laid on the role of gesture in science education research.

Vicente HandaDeborah TippinsNorman ThomsonA Case Study of Community Immersion as a Context for Creating a Community-based Science TeacherPreparationP-203-335-334-371

This paper describes a Philippine experience of community- based science teacher preparation through student and faculty immersion in a Filipino barangay. A barangay is a basic territorial and political unit in the Philippines comprising of a group of people with shared goals, values, culture, and tradition (Panopio and Rolda, 2000). Using a single case-design with multiple units of analysis, this case study examined the learning experiences of two preservice teacher educators in supervising the community immersion of a cohort of 24 prospective elementary science teachers in a rural barangay in an island in central Philippines. Sources of data were interviews, focus-group discussions, student journals, and other archival information. The case experience of two teacher educators was analyzed using an inductive analytic procedure of phenomenology. Findings of the study generated themes from textural and structural descriptions of the community immersion experience. A cross case analysis was presented through composite textural-structural descriptions from individual cases. Conclusions and discussions were situated in relevant literature such cultural relevancy in science teacher education, community-based science teacher preparation, and notions of community and community funds of knowledge.

Daniel Hanley

Evaluating Science Curricula for Higher Education and Professional Development Settings P-288-482-481-518

One product of the North Cascades and Olympic Science Partnership is the development of new Earth and Life science curricula for both teacher preparation and teacher professional development. This related paper set will address the development, implementation, and outcomes of the process. In particular, this paper describes the evaluation of curricula as implemented in the partnering higher education institutions and in the Summer Academies for teacher professional development. Specifically, this paper focuses on changes in undergraduate students and practicing teachers content knowledge in science, beliefs/ attitudes about inquiry-based science teaching and learning, and understanding of their learning process (metacognition).

Deborah Hanson

Influence of Personal Definitions of Science on Science Teaching Self-Efficacy and Classroom Practice P-501-1437-1436-1468

This study investigates one possible factor in forming science teaching self-efficacy, one's personal definition of science and the effect of changing one's personal definition of science on self-efficacy and classroom practices. Participants were thirteen inservice elementary teachers participating in professional development that focused on NOS, inquiry and physical content knowledge. Two participants from the group were purposely selected for case studies. Teacher's definitions of science were measured pre/post by the VNOS- D2 and the VOSI and science teaching self-efficacy was measured by the STEBI. Interviews followed to ensure proper interpretation of responses. Classroom observations validated the teacher's science teaching strategies. During the nine monthly workshop period investigated, the teachers felt more confident in their science teaching abilities and saw statistically significant increases in PSTE scores. Teachers ranked learning about nature of science (NOS) as the most influential in their self- efficacy change. This was further supported by the case studies. Both teachers changed their definition of science by learning NOS and due to this shift, their science teaching self-efficacy and classroom practices changed. Results from this study indicate the importance of teaching NOS as a content area.

Deborah Hanuscin Michele Lee

Across Content and Pedagogy: Seeking Consistency in NOS Instruction in Teacher Education Programs P-489-910-909-943

While reforms emphasize understanding the nature of science (NOS), a challenge in meeting the vision of the reforms is that teachers lack understandings consistent with contemporary views of NOS. Though teacher educators have successfully improved prospective teachers' views of NOS within science methods courses (Akerson et al., 2000) and specialized science content courses for teachers (Abd-El-Khalick, 2001; Author, et al., 2006), recent work questions whether such single-course efforts are sufficient to promote retention of improved views (Akerson, et al., 2006). We explored the development of preservice elementary teachers' views of NOS across their program of study. Utilizing the VNOS-C (Lederman, et al., 2002), we conducted a pretest posttest for treated and comparison groups of both science content (physics) and pedagogy (methods) courses. 71% of participants who received NOS instruction in their science content course exhibited improved views, while only 10% of participants enrolled in a comparison section did so. Those who later enrolled in a methods course that emphasized NOS retained or further improved their views, while those who enrolled in a methods course in which NOS was not a primary focus reverted to their original views. Our findings underscore the importance of consistency in NOS instruction throughout teacher education.

Danielle Harlow

From Physics Courses for Teachers to Elementary Classrooms: The transfer of teaching practices Q-209-345-344-381

In the past decade, several physics curricula have been designed with the needs of prospective and practicing elementary teachers in mind. These curricula use guided inquiry activities to facilitate teachers' conceptual development of physics ideas and to model desired teaching strategies. While there is evidence that such courses help teachers develop physics content knowledge, little is known about what teachers transfer from such courses into their teaching practices. This study is part of an investigation to understand how physics content courses designed for teachers may impact elementary classrooms. Here, I present an analysis of one practicing teacher who participated in a professional development physics course and describe how the physics course impacted one aspect of her teaching practices: the types of questions she asked her students.

Allan HarrisonBarbara CrawfordPenny GilmerJ. Randy McGinnisNew Researcher OrientationS-778-1678-1675-1705

At this session, all first-time NARST conference attendees, as well as any new researchers pursuing careers that involve research in science education, are invited to attend (other interested NARST members are welcome). The goal of this session, in which a distinguished panel of experienced NARST members will discuss how one travels the road from early dissertation work to the myriad of career options, is to provide support via information to new members.

Allan Harrison	Grady Venville	Fouad Adb-El-Khalick	Alan Blakely
Graduate student and	l junior faculty early career	discussion	
S-786-1697-1694-172	24		

This will be a panel discussion by junior faculty, and it will focus on their experiences writing their dissertations and securing their early career positions. They will be sharing tips from the trenches on the writing process, positions at different kinds of institutions, early survival tips and expectations, etc. Dissertations and early job searches can seem overwhelming, and this can be a good opportunity to hear how others have reduced them to manageable tasks. As the New Researcher Orientation has usually focused on the early career, there will be a greater focus in this session on issues related to the dissertation such as time management, project organization, etc.

Mary HeitzmanLeeAnn SutherlandJoseph KrajcikHow do middle school students integrate prose and adjunct diagrams when reading science texts?P-732-1574-1573-1603

The goal of this study is to understand how middle school students use various discursive and representational tools as they read science texts. Science texts frequently employ words and accompanying graphics to communicate information. In order to help students utilize texts as a means of accessing scientific information, and to help them take advantage of this access as another tool in learning science, we must understand how students use prose and graphics when reading. However, research has yet to provide a coherent picture of the ways students integrate multiple representations in science texts. This study therefore asks: How do students integrate prose and adjunct graphics when reading science texts? We analyzed ways with which 20 sixth grade students used prose and diagrams when comprehending both expository and real-world texts. Analyses showed that the points and frequencies with which students looked at diagrams were not significantly different when compared among proficient and struggling readers. Students' looks at diagrams were also not significantly different when the text genre differed. Subsequent analyses will provide a more detailed picture of students comprehension processes, including why students did and/or did not use the diagrams when reading, and when reflecting on, diagrams and prose.

Cari Herrmann Abell George DeBoer

Probing Middle School Students' Understanding of Ideas about Chemistry through Content-Aligned Assessment 0-432-769-768-803

Our goal is to develop an online collection of student assessment items in science that are precisely aligned with national standards. Each item is developed and analyzed using a procedure designed to evaluate an item's match to important science ideas and its overall effectiveness as an accurate measure of what students do and do not know about those ideas. During the item development procedure, the items are pilot tested and used in student interviews. This poster presents assessment items aligned to the middle school chemistry key idea of thermal expansion and describes how we use information gathered from the students to gain valuable insight into students' thinking as well as insights about the quality of the items themselves.

Sarah Hick

How do they do it? Lesson-planning strategies of reform-based and non-reform based first year science teachers P-324-1598-1597-1627

Though most students leave teacher preparation programs professing reform-based beliefs about teaching, few of them enact teaching that reflects reform ideals (Gess- Newsome & Lederman, 1995; Haney et. al, 1996; Radford, 1998). This qualitative study examines the differences in lesson-planning strategies employed by first-year secondary science teachers in order to illuminate the processes associated with developing reform-based science lessons. Findings show that a difference in 'looking for' and 'designing' lessons is pronounced between reform-based and non-reform based new teachers. Additionally, while most new teachers appear to be using schema to help them organize their lessons, non-reform teachers se procedural schema while reform teachers use reform-based schema like What if? s and puzzles like ordering and pattern recognition. Implications indicate a utility for availability (not mandate) of scripted reform-based science lessons and a need for teacher education to help teachers recognize and use reform-based lesson schemas.

Margilee Hilson Kathy Trundle

Teaching Like a Researcher: Evaluation of Student Science Achievement Gains within Teacher Classroom Action Research Projects P-318-548-547-584

This research evaluated three years of archival data from a district wide teacher action research program in a large urban midwestern city. Only the 67 projects focusing on science instruction were considered for inclusion in the study. The purpose of the action research program was threefold: 1) improve student achievement, 2) identify through classroom research the best instructional strategies for promoting student achievement in the urban school district, and 3) recognize, replicate, and disseminate excellence in teaching. Determination of student achievement gain was conducted through comparing the mean difference between pre- and post project standardized assessment data relative to the school district averages. Standardized assessments (e.g., Metropolitan Achievement Test Version 8, state department achievement tests, and district End of Course exams) were administered to students annually. The results suggested that classroom action research has potential to improve student achievement in science as measured by standardized tests scores. In the 42 cases with complete data sets involving 1320 students, the mean student achievement gain above the district average was 3.65 NCE with a 7.96 standard deviation. A Cohen's d effect size of .46 was found for the difference between the pre-test and posttest means of the 42 cases.

Austin HittEmory HelmsPreservice Science and Social Studies Teachers' Perceptions of ScienceD 567 1077 1076 1110

P-567-1077-1076-1110

This presentation focuses on preservice science and social studies teachers' perceptions of science and society. In order to determine their views, an open-ended assessment instrument consisting of 4 items was created, The Science and Society Instrument .The Science and Society Instrument probes respondents' views on the following concepts/beliefs: science is contextual, multiple approaches or styles of science exist, science is an objective progressive endeavor, science and the humanities are incompatible. The responses were analyzed using a rubric based on William Perry's Forms of Ethical and Intellectual Development Scale (1968). In addition, the preservice teacher's epistemological position in Perry's schema was assessed using the Measure for Intellectual Development, MID. Analysis of the Science and Society Instrument data reveals that pre-service social studies teachers maintain a more relativistic and humanistic view of science. A second finding was that preservice science and social studies teachers receive consistent scores across all items on the Science and Society Instrument. Finally, the relative epistemological levels obtained on the Science and Society Instrument parallel the epistemological positions recorded using the MID. These results are indicative of a possible connection between an individual's academic field and their relative position in Perry's Forms of Ethical and Intellectual Development Scale.

Sally Hobson Kathy Trundle

Discourse surrounding the use of planetarium software in an early childhood science classroom P-230-531-530-567

This descriptive study examined the children's talk within an inquiry-based science investigation, and the role talk played in shaping cognition. The guiding questions for this study were (a) What types of talk did the children use? and (b) What purposes did the talk accomplish? In small, self-selected groups children explored the moon using realistic planetarium software, Starry Night. During a four-week period, 21 early childhood elementary students managed their own lunar investigations by developing inquiry-based questions, observing and collecting data, and making decisions about their explorations. Without leaving the classroom, children were able to explore astronomical events and objects with minimal intervention. Data collection consisted of audiotapes, videotapes, field notes, individual student journals, and lunar calendars. Four major types of discourse emerged from the data: cognitive responses, questions, procedural responses, and affective responses. Children's talk revealed two broad themes (1) communication or sharing of ideas and findings, and (2) negotiation of meaning collaboratively. Using planetarium software with young children connected the natural world and the abstract concepts of astronomy, while stimulating discourse and stimulating development of scientific ideas.

Avi Hofstein Reachel Mamlok-Naaman

Three models of professional development. P-784-1692-1689-1719

This seminar will examine professional development of science educators from a variety of perspectives. BouJaoude and Dillon will present the preliminary results of a survey of the readership of science education journals worldwide that aimed to determine the extent to which science educators learn from the experiences of international colleagues. Fraser-Abder will present a global perspective on professional development activities that provide a forum through which teachers can hone their skills, develop, support, and begin to address the specifications of working with their schools . Dillon s contribution will focus on the variation across Europe in terms of science professional development while Hofstein and Mamlok-Naaman will discuss three models of professional development used with Israeli science teachers. Finally, Abd-El-Khalick will focus on professional development for Egyptian teachers by describing two realizations of the Professional growth through engagement model used in large and small scale educational reform projects in Egypt.

Avi Hofstein Rachel Mamlock-Naaman Zvia Kaberman Abeer Abed Liora Saar Nitza Barnea

Emphazing thinking skills and metacognition through reading chemical articles and inquiry-based experiments S-756-1615-1614-1644

Educating high school chemistry students to adopt new thinking and metacognitive skills is a complex and demanding task. This symposium is based on three related studies whose goal was to investigate the effect of exposing high school chemistry students to reading adapted chemical articles and inquirybased laboratory activities. The goal of the first study was to develop, implement, and assess the learning outcomes of a learning unit, which focused on inquiry-based chemistry experiments in high schools in Israel. Students were required to ask questions regarding a presented scientific phenomenon, formulate a hypothesis, choose a researchable question for further investigation, and plan an experiment in order to investigate this question. In the second study we investigated the effect of a chemistry case-based computerized laboratory unit on 12th graders' ability to pose questions and construct models. In the third study we investigated the effectiveness of a self-developed metacognitive tool for high school chemistry students' comprehension of adapted scientific articles. Students were asked to assess the quality of the questions according to a classification taxonomy, which characterizes complex and deep questions. In all three studies, students' thinking skills were assessed using summative assessment tools as part of the Israeli matriculation examinations.

Tamara Holmlund NelsonDavid SlavitWendi LaurenceAngie FosterAnne KennedySupported Collaborative Inquiry and Teacher LearningP-551-1028-1027-1061

This research took place within the context of a three-year professional development project utilizing professional learning communities (PLCs). The research purpose is to understand the dynamics of teachers' growth and change as they participate in supported collaborative inquiry in a PLC. Nine case studies were developed for a purposeful sample of PLCs located in middle schools and high schools, focused on science or mathematics. In this paper, we focus on two categories of teacher learning related to the professional conversations engendered by their collaborative inquiry: understanding students' learning and/or motivation differently, and developing a deeper understanding of external initiatives and how to incorporate these practically in their classrooms. These findings are significant in helping us understand how teachers construe the processes of collaborative inquiry as learning opportunities.

Tamara Holmlund NelsonGreta BornemannRay NelsonCharlotte WatersKristin WhiteTed Wilkins

Teachers' Reflections on Supported Collaborative Inquiry in Professional Learning Communities Q-551-1031-1030-1064

The focus of this poster session is secondary science and mathematics teachers' stories about collaborative inquiry into some aspect of their teaching or their students' learning. Their collaboration is framed by an inquiry cycle in which they define a focus grounded in some element of a co-constructed vision of high quality learning and teaching, develop and implement a plan for change, and collect and analyze classroom-based data to further their understanding. This inquiry process is supported by a three-year professional development project that helps supports teacher development through professional learning communities. Three teachers will each provide a synopsis of his or her PLC's inquiry question, classroom-based data collection, collaborative analysis procedures, and findings relative to student learning and professional growth. Discussion will also consider the supported collaborative inquiry processes and the external supports and challenges to collaborative inquiry.

Kiyra Holt Mary Atwater

Studious Stayers, Loyal Lovers and Dedicated Dreamers: Science Teachers' Perspective on Remaining in the Urban Classroom P-514-1320-1319-1351

This qualitative case study using the responses from interviews investigated the reasons why veteran science teachers continue to teach in an urban school system. Five science teachers from an urban school in the southeastern United States were selected for this study. These teachers represent a variety of backgrounds and years of teaching experience. Four themes emerged from the data analysis: (a) Successful teachers are constantly learning to stay abreast of the ever-changing curriculum; (b) they have found simple ways to maintain effective practices, (c) their love of the actual job of teaching continues to motivate them, and (d) they find ways to collaborate with one another on an ongoing basis.

Kiyra Holt Mary Atwater

Studious Stayers, Loyal Lovers and Dedicated Dreamers: Science Teachers' Perspectives on Remaining in the Urban Classroom 0-514-942-941-975

This qualitative case study using the responses from interviews to investigate the reasons why veteran science teachers continue to teach in an urban school system. Five science teachers from an urban school from an urban school in the southeastern United States were selected for this study. These teachers represent a variety of backgrounds and years of teaching experience. Four themes emerged from the data analysis: (a) Successful teachers are constantly learning to stay abreast of the ever- changing curriculum; (b) they have found simple ways to maintain effective practices; (c) their love of the actual job of teaching continues to motivate them; and (d) they find ways to collaborate with one another on an ongoing basis.

Jun-Euy HongMoon-jung HanYoung-Jun ShinJung Hoon ChoiYoungsuk JeonMaking Newspapers in Biology Class0-680-1386-1385-1417

Instead teacher prepare all things for the lessons, we need very active bidirectional communication on student to student(s), teacher to student(s), such as students centered activities and it can make them to understand scientific knowledge and to get positive attitude to science. For this purpose, after studying 'the characteristics of life' and 'the structure and functions of cells', we carried out a 'making science newspaper' program based on the studied topics with 150 science high school students. Students formed groups of 3 or 4, and each produced and presented a newspaper filled with various items such as comments, reviews, and cartoons. The students' attitude towards this program were generally positive, as one can see from the following responses: 'I believe that making a science newspaper using what we've learned was an interesting project that promoted creative thinking, and was great'; 'The best thing of making a science newspaper was the fact that I could apply ideas and principles I'd learned from books to real-life situations and thus could better understand what I had learned and get more interested in science classes.' index terms : interest for the science, bidirectional communication, students centered class, science newspaper *NARST Annual International Conference 2007*

Meredith Houle Michael Barnett

Students conceptions of sound waves resulting from the enactment of a new technology-enhanced inquirybased curriculum on urban bird communication P-560-1560-1559-1589

Research on the use of information technology in classrooms reveals that students in high poverty urban areas are consistently falling behind their peers. To this end, we are developing informational technology enhanced curriculum modules designed to engage students in learning about science through the use of emerging information technology. In this proposal we describe the impact of one of the developed modules, urban bird bioacoustics, on student understanding of sound. This module incorporates a technology-rich inquiry project with traditional, well-established sound learning activities. Our findings suggest that while the inquiry project was successful, students' understandings of the properties of sound were mixed. These data suggest that instructional designers who are engaged in constructing a similar technology-enhanced curriculum should consider embedding their instructional support resources with appropriate student scaffolding questions, make explicit connections between the inquiry project, technological tools and traditional science activities, and leverage the multiple opportunities to learn content afforded by the technological tool. These findings will be used in next redesign of the curriculum materials. This work both shows how design-based research can be used to build knowledge about student scientific understanding and instructional and curricular design.

Courtney Howard

Avoidance as a Factor in the Under-participation of Blacks in Science: The Impact of Cultural Memory P-251-434-433-470

This paper argues that the cultural memory of African Americans should be included in science instruction to increase and broaden their participation in science. Cultural memory deals with the recollection of the past to position oneself or one's group in the world. A cultural memory of science injustices results in cultural mistrust of science. Cultural mistrust leads to avoidance. Science curricula should directly address those science injustices are currently not learned at school but are learned at home. Science instruction must attend to these memories and help students to reconcile competing images of science. This will counteract the mistrust and help broaden participation.

Elaine Howes

Emotion and Particularity in Learning about Plants: P-491-1438-1437-1469

The teacher research study I am reporting on here a small part of an ongoing effort to learn what my students are learning, and how they think of science in terms of their own teaching. I focus here on their journal writing, for the purpose of exploring their experiences during the long-term plant study. I draw on data from two sections of elementary methods taught in the same semester. As each section consisted of at least 25 students, I have journal writing from more than 50 students. From a phenomenological perspective, I analyze students' questions and their expressions of emotions during a long-term science inquiry into the life cycle of green, flowering plants. I attempt to make sense of what sense students are making, rather than compare what they learn to scientific understandings. The main themes in the paper are students' emotional engagement in the life of their plants and the particularity of students' questions. I discuss students' expressions of emotions, their questions about their plants, and the issues that the phenomenon of emotional attachment to the object of study may bring to mind for science teacher educators committed to inquiry-based science teaching and to valuing their students' thinking.

Ying-Shao Hsu Li-Fen Lin

I-Chung Ke

Hsin-Kai Wu

Fu-Kwun Hwang

A Comparison of Experts, Intermediates, Novices, and Naives in Modeling P-548-1020-1019-1053

This study aims to compare the differences in the modeling processes concerning phenomena of air quality and pollution among experts (atmospheric scientists), intermediates (non-atmospheric scientists), novices (talented 12th and 11th graders), and naives (average 10th graders). From the analysis of interviews, experts' plans were theory-based, they conceptualized air quality variables structurally, and they explained the mechanism how variables influence air quality. The non-atmospheric scientists did not include theoretical verification in their research planning, and they were not able to determine the dominant variables, probably due to the lack of subject knowledge. The novices' research designs were not theory-driven, but their designs followed the general model of scientific experiment and tended to be more rigid than naives' designs. Naives designed the air quality experiment based on their experiences and only used a single manipulating variable at a time and they were unable to determine the dominant variables. A significant difference between the groups on modeling air quality was the fundamental reasoning process. The experts used model- based reasoning; intermediates and novices used relation-based reasoning while naives used phenomena-based reasoning.

Pei-Ling Hsu Michael Roth

Bridging science activities to students: Discursive approach for analyzing discourse in a biology classroom P-66-223-222-259

The National Science Education Standards state that all students should experience quality science instruction rooted in authentic experience and most science researchers encourage teachers to guide students to access science more authentically. However, little is known about how teachers introduce or promote these science activities to their students. The purpose of this ethnographic and discourse analytic study is to investigate the ways in which a high school biology teacher discursively represents the activities of scientists to students. We collected data in the form of observations and field notes and we videotaped lessons in an eleventh-grade biology class. Drawing on discourse analysis to investigate the kinds of interpretative repertoires the teacher uses to introduce science activities, our analysis identifies six types of repertoires, reports frequencies and demonstrates repertoires change through interaction, demonstrate their frequencies and investigate their interacting work. The nature of the discursive resources teachers use has important implications for improving science education quality because of the likely influence on students' image of science and allows us to understand how discourse is conveyed and how it reflects the contexts of communities, language and common sense assumptions in science classrooms.

Pei-Ling Hsu Michael Roth

Reciprocal Expertise of Apprenticeship in Authentic Laboratories Q-66-483-482-519

Apprenticeship and scaffolding have received considerable interests by educational researchers and practitioners as forms of inducting students to science. Some studies indicate that scaffolding is a one-way process, especially when it is understood as direct instruction. The purpose of this ethnographic study is to investigate how scaffolding of apprenticeship is deployed in scientific laboratories. Thirteen high school students were divided into four groups to participate in four different scientific projects. Data were collected through observation, field notes and videotaped science sections. Drawing on discourse analysis to illustrate the individual/cultural perspective of scaffolding in apprenticeship and to demonstrate expert-orientated scaffolding actions and novice-orientated angling scaffolding actions, we better understand micro aspects of apprenticeship of mutual scaffold-related actions in authentic settings.

Liang-Rong Hsu

Using the Sequential POE to Explore Students' Abilities for Scientific Explanations Q-86-259-258-295

The purpose of this study was to explore students' abilities for scientific explanation by using the S-POE (Sequentially Predict-Observe-Explain) technique. The S- POE was developed by the research which included four POE tasks that focused on 'surface tension' and 'atmospheric pressure'. The subjects were 29 sophomore students who majored in science at a national university in Taiwan. The major findings are summarized as follows: (1) only 13 (44.8%) of the students made scientific explanations for the common phenomenon of atmospheric pressure; (2) only 13.8% students proposed an appropriate explanation for the relationship between surface tension with atmospheric pressure; (3) despite the students being majors of science and are familiar with the knowledge contents of the POE in this study, but their ability of explanation was obviously insufficient and lacked 'explanatory coherence'; (4) The students had a tendency to explain the phenomenon using their intuitive ideas instead of the scientific term. In view of the above findings, we have to reconsider to how to promote the students' abilities of applying knowledge to explain the natural phenomena.

Ya-Ling Huang Hsin-Kai Wu

Ninth Graders Conceptual Understanding and Cognitive Engagement in Teacher-centered and Studentcentered Technology-enhanced Learning Environments P-418-742-741-776

The purpose of the study is to investigate ninth graders' conceptual understanding and cognitive engagement in teacher-centered and student-centered technology-enhanced classrooms. Fifty-four students in two classes from a public junior high school in Taiwan participated in this study. The results appeared no significant differences between the two classes in the pre- and post-tests of conceptual understandings. Yet, the gain scores of the tests showed different patterns across achievement groups in the two classes. In the teacher-centered class, students in the low achievement group gained the most, while in the student-centered class, medium and high achievement students improved the most. Additionally, the analyses of classroom observation showed that students in both classes were cognitively engaged. Students in the student-centered class usually interacted through describing ideas, while students in the teacher-centered frequently engaged in questioning. In the student- centered class a majority of questions students generated were related to the worksheets and learning tasks, but in the teacher-centered class, questions asked by students were mostly genuine, conceptual and not relevant to the questions on the worksheets. The findings suggest that the two instructional approaches provided students with different opportunities to cognitively engage in technologyenhanced learning environments.

Tingho Huang Jennifer Cartier

Students' Learning of Measurement Concepts and Skills through a Hands-On Science Curriculum P-716-1520-1519-1550

Recent science education reforms emphasize engaging students in inquiries to develop conceptual knowledge. Hands-on science materials often consist of detailed instructions about how to do activities, but few instructions on scaffolding opportunities for scientific inquiries through those activities. This study compared students' learning of measurement concepts and skills by looking at the implementation of a hands-on science curriculum in three teachers' classrooms. Students' learning was examined using a written assessment and a performance interview. The results showed that two teachers emphasized student ideas of measurement, whereas the other teacher simply focused on step-by-step measurement procedures. Students performed similarly in their measurement skills but differently in their ability to make reasonable estimations, depending on whether teacher instructions targeted measurement concepts in addition to procedures. Not all students acquired conceptual understandings of measurement, even after repetitive practice with procedures. Moreover students' choices of measurement tools were informed by several purposes. For example, they sometimes selected the most expedient tool but ignored the need for using standardized units of measure. Because students seemed to prioritize different purposes on different tasks, we propose that these alternative ideas about measurement can co-exist for students who are developing conceptual expertise.

Regina Hübinger

Elke Sumfleth

Changing Teachers Instruction to Improve the Acquisition of Students Experimental Competencies Q-588-1123-1122-1156

The aim of the study is to develop and evaluate instruction materials for students in the first years of science education and an additional teacher training program. The main request of the intervention is to show how students' learning can be supported in scientific inquiry. According to this, the instruction materials and the training program are based on the assumption that it is efficient to structure instruction and students' learning processes with the aid of scientific inquiry, especially by clarifying the role of experiments. To investigate changes of teachers' instruction two lessons of the participating teachers (N=6) are videotaped, one before and one after the teacher training program. Additionally, the teachers are asked about their beliefs and attitudes about instruction in a pre-post design, so that differences before and after the intervention can be assessed. These data are compared to teachers of a control group (N=20). Supplementary, students of both intervention and control group teachers are investigated with a test of scientific inquiry in a pre-post design. This leads to evaluation of the developed materials and the teacher training program. Positive results of the study offer teachers practical advice of how to improve students' experimental competencies.

Douglas Huffman

Anita Lundy

Evaluation and Assessment Capacity of Urban Schools: Engaging Elementary Teachers in Collaborative Evaluation Communities P-19-145-144-181

The purpose of this paper is to describe the impact of a model of evaluation and assessment capacity building in science education. The Collaborative Evaluation Communities Project was funded by The National Science Foundation to develop the evaluation and assessment capacity of urban schools, and specifically develop the evaluation capacity of elementary teachers in the area of science education. The project tested out a new model of immersing elementary teachers in the evaluation process. Building the evaluation and assessment capacity of K-12 teachers and schools is an important goal for the field of science education. Teachers are overwhelmed by data; however, they do not always have the capacity to use data. The Collaborative Evaluation Community Project used an inquiry cycle to immerse teachers in the evaluation process as a means of improving their science instruction and capacity to use data. Survey and interview results indicate the project altered the extent to which teachers' engaged students in more inquiry-oriented science activities. Implications of results for developing evaluation capacity of schools and teachers are discussed.

Ching Sum Hui Benny Hin Wai Yung

Developing Student Teachers' Conceptions of Good Science Teaching: The Role of Video Workshops Q-412-733-732-767

Eleven student teachers were prompted to reflect progressively on their conceptions of good science teaching (CoGST) through reviewing and reflecting on videos of exemplary science teaching in a series of workshops. The development trends of student teachers' CoGST were monitored through various written tasks including reflection essays and concept mapping. Results show that most student teachers found the videos very useful in providing concrete teaching exemplars that they could apply in their teaching practice. In addition, the structured interventions and scaffolding activities at different stages of the video workshops also played an important role in the development of student teachers' CoGST. The study contributes to the literature on design of initial teacher education that advocates for the use of videos within the reflection orientation, in particular, to those aiming at helping student teachers to construct and develop their own conceptions of teaching and learning.

Anne Hume

Curriculum Intent and Classroom Reality P-767-1652-1649-1679

This present work reports on the reality of classroom-based inquiry learning in science, from the perspectives of students and their teachers, under a national curriculum supposedly encouraging authentic scientific inquiry (as practiced by scientists). In two Year 11 classes (15-16 year olds) from different schools, data were gathered from interviews, classroom observations and relevant documentation to build a comprehensive picture of what science students were learning, and why and how. The findings found significant differences between the national policy expectations and the actual learning. Classroom teaching projected a narrow view of scientific inquiry, focusing on fair testing in closed rather than open investigations. This learning was strongly influenced by curriculum decisions made by classroom teachers and science departments, in response to the assessment requirements of a high stakes national qualification.

Anne Hume Richard Coll

Student Engagement in Authentic Scientific Inquiry: The Curriculum Intent and the Classroom Reality P-263-447-446-483

Student Engagement in Authentic Scientific Inquiry: The Curriculum Intent and the Classroom Reality Internationally progressive science educators are recognizing that inquiry- based learning in school science programs may help to support new scientific literacy goals in society. This work reports on the reality of classroom-based inquiry learning in science, from the perspectives of students and their teachers, under a national curriculum attempting to encourage authentic scientific inquiry as practiced by scientists. In two case studies of Year 11 classes (15-16 year olds) from different schools, data were gathered from interviews, classroom observations and relevant documentation. The use of metaphors and narrative style to present the findings revealed a rich picture of what science students were learning, and why and how this learning occurred. The findings suggest students were acquiring a narrow view of scientific inquiry, with a focus on fair testing in closed rather than open investigations, and this tended to result in rote, low-level learning. This learning was strongly influenced by curriculum decisions made by classroom teachers and science departments, in response to the assessment requirements of a high stakes national qualification. These findings have implications for curriculum and qualification developers and teachers of science, particularly the viability of students experiencing authentic scientific inquiry in classroom programs.

Kristen Hutchins

Patricia Friedrichsen

Examining Life Science Professors' Views of Learning and How That Affects Their Teaching P-381-1544-1543-1574

The purpose of this phenomenological study was to explore college science professors' experiences as adult learners/teachers with the goal of gaining a better understanding of the kinds of professional development that can best support college science professors. The researchers sought to understand the participants' views of learning and how they related to their teacher knowledge. Participants included 3 female and 3 male college life science professors. Data was collected through multiple sources: three semi-structured interviews, a card sort activity, and a researcher's journal. Data analysis involved open coding of the interview transcripts and researcher's journal, followed by the identification of emergent themes. Findings indicated that there was disconnect between the participants' views of learning; however, they rarely applied those views to their classroom. These findings suggest a strong need for professional development to support college science professors in aligning their beliefs with their teaching practice.

Kelly Hutchinson	Namsoo Shin	Shawn Stevens		
Nicholas Giordano	George Bodner			
Exploration of Student Understanding and Motivation in Nanoscience				

P-645-1353-1352-1384

We investigated 7-12th grade students interest and motivation in nanoscience concepts and phenomena. Certain types of topics may be used to motivate students to learn nanoscience concepts, therefore we investigated how students interests vary among school context, grade level, gender, ethnicity and academic ability. A survey of 416 students in urban, suburban and rural communities measured interest in the nanoscience-related topics and phenomena. We found that a majority of students expressed at least some interest in many nanoscience-related topics and phenomena as they were presented. However, interest levels differed according to gender, grade, and ethnic background. From student interviews, we identified categories that govern student interest including: hands-on activities, use of chemicals and how it relates to the student s everyday life, prior knowledge, prior experience, and/or personal interests. While hands-on activities were a strong factor in student generating interest, this alone was not enough to sustain it; other factors also play a significant role in student interest and motivation. These results can contribute to the efforts of curriculum developers and instructors to create engaging and motivating experiences for students, which may lead to increased student learning and understanding in nanoscience and science in general.

Molly Yunker

Tracy Huziak-ClarkLena Ballone DuranStephen Van HookSvetlana BeltyukovaJulie Nurnberger-Hagg

The impact of the Partnership for Reform through Inquiry in Science and Mathematics (PRISM) program on teachers' self efficacy and beliefs about inquiry-based science teaching. P-98-165-164-201

This study evaluates the impact of PRISM on teacher self- efficacy and beliefs. The presentation will include an overview of this NSF GK-12 program, its summer institute and academic -year program. This research shows positive changes in self-efficacy from the graduate students and the teachers in the program. A dependent t-test showed that there was a significant change in teacher beliefs from pre to post assessment (t19 = 3.178, p<.01). In addition to changes in attitude three main themes were found from the journal prompts to support changes in teacher self- efficacy: Increased Confidence Level, Enthusiasm for Science Teaching and Importance of Inquiry-Based Teaching. These results and themes will be further elaborated.

Sheliza Ibrahim Steve Alsop

A Pedagogy of Public Science: Mapping the production of science in the media with science writers, and analysing a contemporary science issue - Avian Flu Q-259-1631-1628-1658

The pedagogy of public science is examined through two case studies. The first case explores the complexities that govern public science communication and its social construction through a series of interviews with science writers. The second case critically deconstructs a contemporary science issue in the media: Avian flu. Drawing on Giroux (1989) we connect scholarship in public pedagogy to the public's ability to facilitate learning from science in the media: Pedagogy of Public Science. We draw on both case studies, utilizing our data sources: interviews and media analysis, to propose emergent pedagogical dimensions used in the communication of scientific knowledge. For informal learning, as identified by Alsop, (1999), they are affective, cognitive and social dimensions. We propose an alternative scholarship that carries significance for the practice of science writing, the journalists who engage in this work and the representation of science knowledge in the media. Particularly, our study suggests a shift in pedagogical culture for public spaces and their writers, offers an insight into how the public negotiates science concepts when they exist in contemporary forms (media), and suggest how educators might prepare students and publics to become adept members of popular science culture.

Hatice Inan Kathy Trundle Rebecca Kantor

An Exemplary Approach to Natural Sciences Education in Preschool: Reggio Emilia P-348-1094-1093-1127

This qualitative case study explores aspects of how the natural sciences are represented in a Reggio Emiliainspired laboratory preschool at a Midwestern research university. Natural sciences, a latecomer to preschool curricula, and the internationally-known approach, Reggio Emilia of Italy, have interested educators and researchers, but there is little research about Science in Reggio Emilia. The current research aimed to gain insight into natural science experiences in the Reggio Emilia- inspired classroom. To gain in-depth information, this inquiry-based study adapted a qualitative contextual design, which is a case study design, and various data collection techniques (i.e., interview, observation, document/artifact collection, and field-notes). The study involved 18 preschoolers, 10 teachers, and a program director. The results indicated that the Reggio Emiliainspired preschool offered a science-rich context that triggered and supported preschoolers' inquiries, and effectively engaged preschoolers' hands, heads and hearts with science. The Reggio Emiliainspired preschool in this study even exceeded the PreK standards for natural sciences. The results showed that the Reggio pedagogy, grounded in inquiry, is very compatible with science education goals.

Mine IsiksalElvan AlpHamide ErtepinarIn-service Science and Classroom TeachersAttitudes toward Inquiry-Based and Technology-enhancedInstructional StrategiesP-301-511-510-547

The purpose of the present study was to investigate the effects of school type and educational branches on in- service teachers' attitudes toward inquiry-based and technology-enhanced instructional strategies, and their self-efficacy beliefs on effective science teaching. Data were collected by the administration of Teacher Attitudes toward Instructional Strategies Questionnaire to 51 elementary science and 122 K-5 classroom teachers working in elementary public and private schools in Ankara, Turkey. The findings indicated that in-service science and classroom teachers had favorable attitudes toward using inquiry-based instructional strategies, whereas they did not have strong attitudes toward technology-enhanced instructional strategies or quite favorable self-efficacy beliefs on effective science teaching. Two-way MANOVA results showed no significant mean difference across scores of using inquiry-based and technology-enhanced approaches with respect to teachers' educational branches and school type. However, teachers attending private schools had significantly higher self-efficacy beliefs on effective science teaching than those attending public schools. Additionally, compared to the classroom teachers, science teachers showed significantly more favorable self- efficacy on teaching science. Based on the findings, it is recommended to focus on programs that target science and classroom teachers to participate in collaborative, sustained, inquiry-based and technology-enhanced activities, and professional development experiences.

David Jackson Leslie Jones Norman Thomson Joy Dike Samuel O'Dell Raymond Freeman-Lynde

The 'Other' Literature of Evolution/Creationism and a Serious Attempt at its Application S-744-1594-1593-1623

When we, as science educators, speak of the issue and the literature of teaching about biological evolution and its relationship to creationist ideas and wordviews, we tend to assume, first, that the exclusive, or at least central, theater of conflict in this battle is the high school biology classroom; and second, that the two major prongs of the academic literature on this topic, those of empirical studies in education and theoretical, philosophical treatises specific to the science/religion interface, largely exhaust the relevant texts. In this symposium we survey this issue through presentations that whose focus evolves gradually from the theoretical to the practical, from the formal to the informal, and from the more traditional to the less traditional. Presentations include: The role of the history of science in teaching about evolution; the role of the philosophy of biology; the treatment of these topics in college-level biology texts; the interaction between scientists and the general public in the pre-eminent internet newsgroup on the subject; and a description of an ongoing curriculum development project using the insights gained from these disparate sources to teach students in middle school integrated science classes about hominid and human evolution.

Sheraton New Orleans Hotel • New Orleans, LA

Christina Jacobs Susan Yoon Tracey Otieno

The effect of University science faculty beliefs on pedagogical transformation and transfer P-247-588-587-624

We examine here the extent to which University science faculty reform their teaching practices when exposed to new teaching contexts and directed professional development, and the structural and psychological barriers that preclude them from doing so. Eight University science faculty members were followed as they participated in an NSF-funded Math Science Partnership (MSP) project serving practicing secondary science teachers. The goals of the MSP with respect to its faculty are two-fold. First, through discussion of educational theory and the instructors' beliefs about teaching during faculty meetings, the MSP aims to support a research-based and reform-oriented transformation in the faculty's teaching practices. Initial discussions with faculty members have focused mainly on utilizing new pedagogical understandings in the context of their MSP courses. However, a secondary program goal is for the transfer of their new pedagogical knowledge from the realm of the MSP into the environment of University undergraduate courses. This study seeks to measure quantitatively the faculty's use of reformed teaching practices in two teaching contexts, and to utilize qualitative analysis to understand and categorize the beliefs that impact the instructors' abilities to transform and transfer their teaching practices using newly available pedagogical knowledge.

Tina Jarvis

The Use of Mobile Wireless Technologies to Augment Displays in a Science Centre P-176-285-284-321

The use of handheld multimedia devices was trialled at the National Space Centre in Leicester between June and August 2005. Material was developed to cater for family groups, school parties and people from Leicester's, Guajarati speaking, majority ethnic group. Visitors could choose to download activities relating to 6 current space missions such as the Rosetta probe and the Cassini-Huygens exploration of Saturn and its moon. Activities included quizzes, songs and interviews with and bibliographies about scientists. The Guajarati version included culturally specific information about the Indian Space effort and the Hindu religion. 200 members of the public, 33 Gujarati visitors and 197 pupils aged 12-15 took part. Data were collected though questionnaires, observations and interviews. There was an overwhelmingly positive response to the handhelds. All visitor groups valued the interactive nature and independence of choosing content. Visitors spent far longer in the gallery than those without handhelds. While individuals appeared isolated while using the handhelds and museum environment were needed to improve accessibility and interaction between the handhelds and displays.

Carla JohnsonJane KahleJamison FargoA Study of the Effect of Sustained, Whole School, Professional Development on Student Achievement in ScienceP-164-1242-1241-1273

This longitudinal study of middle school science teachers explored what relationship, if any, exists between teacher participation in whole school, sustained, collaborative, professional development and student achievement in science? Eleven teachers from Glendale Middle School participated in the Discovery Model Schools Initiative two-week summer institute, followed by monthly release day professional development sessions focused on implementing instruction outlined in the National Science Education Standards. Student achievement was assessed using the Discovery Inquiry Test in Science. The same students completed the test in grades 6-8. Students of teachers at Glendale Middle School significantly outperformed students at the control school. Findings in this study revealed the positive impact that whole-school, sustained, collaborative, professional development programs have on student achievement, indicating that programs of this nature could be a means to narrowing or eliminating achievement gaps in science.

Philip Johnson Peter Tymms Shaun Roberts

The development of a computer-based instrument to assess students' understanding of the concept of a substance P-252-416-415-452

This paper describes the development of a computer-based instrument to assess students' concept of a substance. With reference to the literature, a case for such an instrument is argued on two fronts. One, that there is a need to assess an individual student's understanding across a range of basic phenomena involving matter and that the concept of a substance is an organising idea around which this can be usefully structured. Two, that there is a need to assess a large representative sample of students and that a computerised-based platform offers advantages over pencil and paper tests, particularly with regard to incorporating some of the responsiveness which is such a strong feature of the interview. The instrument is also designed to screen for ideas which are thought to inhibit scientific understanding. Data from the trialling of items (with students aged 11-15) will be presented. In addition, the instrument has the built in capability to apply Rasch modelling and preliminary findings concerning the possibility of a unidimensional scale of difficulty for aspects of the concept of a substance will be reported.

Heather Johnson Daniel Edelson

Making Connections in a Project-Based Curriculum P-539-995-994-1028

This study investigates two high school teachers' enactments of a project- based science curriculum in order to uncover how teachers establish and sustain the project context. Establishing the project context refers to how teachers introduce the project goal and role. Sustaining the project context describes the way teachers help students draw connections between daily activities and the underlying project to situate student learning throughout the unit. Findings reveal variations in enactment across the two teachers, particularly in when and why the teachers make connections to the project. One teacher established the role and goal of the project early on and created a coherent storyline that sustained the context. The enactment of the second teacher resembled a more traditional format. Each daily activity stood as an isolated component, with no context ever being established or sustained. Student data indicates a deeper understanding of the project scenario and related content in the first classroom. Additionally, students from this classroom were more engaged, absorbed, and confident in their work. The identification of effective strategies for sustaining the project context can inform the design of necessary supports for teachers to more comfortably and successfully bring inquiry practices, such as project-based approaches, into their classrooms.

Carla JohnsonJane KahleCharlene CzerniakTerry McCollumEffective standards-based instructional environments and narrowing of achievement gaps in science:What
the research tells us and where to go from here?S-164-1161-1160-1193

This symposium will feature leaders in science education research in the arena of teacher effectiveness and student achievement who will share over a decade of research, including recent findings that demonstrate the ability of effective science instruction to eliminate achievement gaps between white and minority students. Symposium presenters will share findings from three large-scale federally funded projects, including how research in each built upon the previous findings. The symposium panel will lead the participants in an interactive discussion about the implications of current research on future research in this area.

Carol Johnston Fiona Goodchild

Scientists in the Secondary Classroom: Effects on Middle School Students Future Enrollments in Science Classes Q-462-833-832-867

This paper explores the impacts of the Let's Explore Applied Physical Science (LEAPS) GK-12 Project in which science graduate students work in secondary science classrooms to mentor students and assist with instruction. Specifically, this study reports on the effects of the LEAPS program on middle school students' continued enrollment and success in science classes throughout high school. We tracked the academic progress of LEAPS students in their high school courses and compared their records with overall school data, tracking differences based upon gender and ethnicity. We also collected surveys from secondary students to gather information about their backgrounds and attitudes toward science and scientists. This project is supported by NSF GK-12 Award # 0139365.

Sheraton New Orleans Hotel • New Orleans, LA

M. Gail Jones Amy Taylor James Minogue

Bethany Broadwell

Eric Wiebe Glenda Carter The Efficacy of 'Powers of Ten': Concepts of Size and Scale P-125-201-200-237

The film Powers of Ten is often employed to catalyze the building of more accurate conceptions of scale, yet its effectiveness is largely unknown. This study examined the impact of the film on students' concepts of size and scale. Twenty-two middle school students and six science teachers participated. Students completed pre- and post-intervention interviews and a Scale Card Sorting (SCS) task; all students observed the film Powers of Ten. Experienced teachers' views on the efficacy of the film were assessed through a survey. Results showed that the film had a positive influence on students' understandings of powers of ten and scale. Students reported that they had more difficulty with sizes outside of the human scale and found small scales more difficult to conceptualize than large scales. Students' concepts of relative size as well as their ability to accurately match metric sizes in scientific notation to metric scale increased from pre- to post-viewing. Experienced teachers reported that the film was a highly effective tool. Teachers reported that the design of the film moving slowly from the human scale to the large and small scales and then quickly back again was effective in laying the foundation for understanding the different scales.

Gail Jones Stephanie Kurtts Catherine Matthews Kimberly Bowie Tammy Smallwood William Sharpton

Equity and Ethics Committee-sponsored Symposium: Inclusionary Science Teaching S-784-1688-1685-1715

Over the past decade and a half, there has been a series of calls for greater collaboration between classroom teachers and special educators to develop and implement instructional models and practices that can be used in the mainstream classroom and still teach to the strengths of special needs students, particularly those who are English language learners. A number of these calls have focused specifically on science instruction, as science has been suggested to be one of the most valuable subjects that can be taught to students with disabilities (Patton & Andre, 1989). Science also may be the subject most responsive to mainstreaming special needs students (Atwood & Oldham, 1985; in Norman & Caseau, 1994, p. 22), partly because it incorporates elements such as concrete, hands-on learning activities and group interaction, and also because of its potentially high interest level. Nonetheless, the large proportion of special needs students receiving failing or borderline passing grades suggests that their science learning needs are not, in fact, being adequately met in the regular classroom (Cawley, Kahn & Tedesco, 1989; Donahoe & Zigmond, 1986). A major reason for this is mainstream classroom teachers' lack of knowledge regarding how best to include students with special needs into their regular classroom activities, e.g., what kinds of instructional models are most appropriate for use with those students (Norman & Caseau, 1994). But as students with disabilities spend increasingly more time in general education classrooms and more than half already go to general education classrooms for science instruction the ability of general education teachers to include these students in all learning activities becomes even more important (Hallahan & Kauffman, 1988, in Norman & Caseau, 1994; U.S. Department of Education, 1991). Researchers and practitioners indicate that no one model is ideal for all students or all disabilities; nonetheless, there are best practices that can teach to the strengths of special needs students while meeting the educational needs of regular education students. Many of these practices tend to be inherent in good science teaching in general, but various modifications may be required to maximize their benefit to students with varying levels of experience and ability. It is imperative, therefore, that teachers work together closely to understand and diagnose the specific learning needs and styles of their students. This session proposes an interactive panel session to discuss ways in which science educators in mainstream classrooms can truly teach science for all and thus meet the needs of all of their students.

Huang JuJian JuSearching for real-time science learning materials: A study of the structures and implications of sciencenews briefs in TaiwanQ-274-454-453-490

Under the ever-changing world, people need more and more literacy to cope with the numerous but chaotic messages. So far, it does require a constant, continuous, real- time, renewable and updating lifelong learning materials to cultivate modern citizens to own both media literacy and scientific literacy at the same time. From this point of view, this study tries to start from theories in journalism and through content analysis, to analyze the dimensions and meanings of science news. Furthermore, the implications in science education are also lighted upon. The questions researched in this study are divided into two main parts. The first one probes into the concept structure and type of science news, and the second analyzes the distributions and features of various science news in Taiwan. This study shows the structures and frequency distributions of science news reports in Taiwan, it also lead to the pictures that Taiwanese news media pay peculiar attention to some levels of science news reports. And these levels also reveal Taiwan people's degree of acceptance towards relevant issues. From these remarks, they would be helpful to further researches and implications in applying science news to public understanding of science.

Ajda Kahveci

Gender Equity in Undergraduate Science: A Women's Program and Strategies for Transofrmation P-276-457-456-493

Women's underrepresentation in science, mathematics and engineering (SM&E) fields in the United States, continues to be one of the main themes in current research. The context of this research was a women's program at college level aiming to increase women's participation in SM&E. My purpose was to shed light on the Program's influence, and to what extent and in what way such a program might produce strategies to enhance gender equity in science and science education. The research was driven by the symbolic interactionist tradition within qualitative approach. Engeström''s cultural-historical activity theory provided units of analysis for the cases. The data sources were participant observations, interviews, and documents. Data analysis involved coding and cross-comparisons. None of the women in the research showed evidence of actively participating in reconstructing and transforming the social relations involved in SM&E, in lines with the Program's liberal feminist approach. The strong emphasis on the sense of community and the SM&E networks within such programs, typically used for providing academic support, can become effective means of critically approaching the SM&E culture. I argue that such programs may provide promising contexts for primarily two strategies for transformation, explicit and implicit transformation, the latter being more influential.

Murat Kahveci

Investigating the Existence of Interactivity in various Instructional Settings P-65-1262-1261-1293

Although there is no agreement as to what interactivity and interaction mean in educational literature, researchers are in agreement that both terms are vital for teaching and learning one way or another. By adding a Strand Category on 'learning environments, teacher-student and student-student interactions, and factors related to affecting learning,' the National Association for Research in Science Teaching (NARST) 2007 is an evidence of the current research trend of instructional interaction in researching science teaching. As a part of larger study, this paper focuses on the faculty members' perceptions about the existence of interactivity in various instructional settings. The sample (N=2669) consists of faculty members at colleges of education at randomly selected universities around the world. On the factor solutions Textbook, Use of Computer, and Classroom, eight-way factorial ANOVA (General Linear Model) was performed to elaborate the differentiations and tendencies of the perceptions of the faculty members over eight predictors: gender, age, highest degree obtained, research interest in interactivity, present status, learning preference, geographical region, and department.

Spartak Kalita Dean Zollman

Investigating Students' Ideas About X-rays While Developing Teaching Materials for a Medical Physics Course

P-762-1639-1636-1666

To investigate students' transfer of learning in the X-ray medical imaging context we have conducted a series of clinical and teaching interviews. The interview protocols were design to ascertain how students dynamically transferred both everyday experience and learning from formal courses to a practical application. This research is part of an effort to design teaching-learning materials for pre-professional students who are completing an algebra based physics course. Some of the proposed learning materials were used in the teaching interviews. The students brought to our discussion pieces of knowledge transferred from very different sources such as their own X-ray experiences, previous learning and the mass media. This transfer seems to result in more or less firm mental models which often are not always internally consistent or coherent.

Darius Kalvaitis

Childrens Relationship with Nature: An Exploration through the Drawings and Voices of Young Children P-540-996-995-1029

This study investigated and described children s constructions of and experiences with nature. Researchers have argued that the human relationship with nature is transcendentally important and yet has been ignored at risk to our own psychological well-being. The purpose of this research was to describe and document the perspectives of children s lives in relation to nature. What are children s relationships with nature? was investigated through a phenomenological and phenomenographic research study using multiple methods of data collection and analysis. Data was collected by asking children to draw and write about themselves in the natural world followed by focus group interviews. The drawings and interviews tell a number of different tales about children s relationship with nature. There appears to be children with a deep connection to nature as well as those who have a very tentative relationship. This study aims to open up a new line of research by looking at children s epistemological and ontological constructions of knowledge. The way that children construct their understanding of the natural world is significant for educators to consider for it may help reveal pathways to deeper children s scientific understanding.

Allison Kang

Research Laboratory Experiences of Undergraduates in Science: The Mentor-Student Relationship for Underrepresented Minorities P-138-1201-1200-1233

As our nation becomes more diverse, there is a need to provide high quality science education for all students. However, despite efforts to increase women and minorities in science, lack of diversity in the science field still persists. One area of impact geared towards increasing the under-representation of women and minorities in science focuses on the undergraduate research experience. Studies show that a summer research experience has an impact on the persistence and retention of students in science. Also, the relationship between the mentors in the laboratory and student has been shown to be important in the student's experience of science. In this study, we look at one specific undergraduate summer research program at a university in the west coast, Pacific Northwest University (PNW). Four female minority students of this summer program are interviewed to gain insight into their experience with their laboratory mentors and how this impacts their retention and perception of science. Based on the analysis of the data from these cases, the prevailing themes from the interviews show how their research laboratories have affected these students' interests in science and how their female minority status has impacted their experiences.

Nam-Hwa Kang Grant Smith Molly Bloomfield

Student Inquiry Learning through Environmental Health Science Curriculum: Preliminary Findings P-561-1062-1061-1095

The purpose of this study was to examine students' learning through their experience of environmental health science curriculum in terms of inquiry questioning and inquiry approaches to answering their own questions. A total of 168 9th-grade high school students taught by two teachers in one school wrote responses to environmental health issues at the beginning and at the end of a nine weeklong curriculum module. In the pre-journal, students responded to the case as consumers and took on passive roles. They asked about simple information frequently and mentioned passive approaches to answering the questions accordingly. In contrast, in the post-journal, students took on a researcher or investigator role as they asked questions more about data analysis, sought an explanation and desired to collect and analyze data to answer their questions. Moreover, students' approaches to answering their questions were more directed indicating their understanding of the connection between questions and inquiry methods. At large, students seemed to transform their position in responding to the case throughout their experience of the new curriculum. Further research on other aspects of inquiry learning and the elements of the curriculum that helped the students to transform their positions will provide some insights into curriculum development and classroom enactment.

Yilmaz Kara

The study of the effects of two educational softwares on students' academic achievements, misconceptions and attitudes towards biology P-555-1039-1038-1072

The purpose of this study was to compare the effects of two compurer-aimed materials, tutorial and hybrid design (called 'edutainment') educational software, on students' academic achievement, misconceptions and attitudes with respect to photosynthesis topic. The study conducted in 2005-2006 academic year was carried out in three different classes taught by the same teacher, in which there were ninety 11th grade high school students in Turkey. An experimental research design including the photosynthesis achievement test (PAT), the photosynthesis concept test (PCT) and biology attitude scale (BAS) was applied at the beginning and at the end of the research. After the treatment, experimental group using tutorial software and experimental group with edutainment software increased general achievement in PAT 24, 0% and 16, 9%, respectively. This result showed that using educational softwares in teaching photosynthesis topic was very effective for students' achievement. Although misconceptions in experimental group, statistical analysises showed educational softwares did not significantly lead changing major misconceptions related to photosynthesis topic, as expected. Moreover, it was also found that there exist the significant differences in even students' attitudes among experimental groups.

Douglas Karrow

Metaphysics as Physis: An Alternate Disposition for the Teaching and Learning Relationship in Science Education P-246-1125-1124-1158

Of the four fundamental ways of being in the world, Heidegger (1962) argued that being-with or relationship is one that is largely unproblematic. In response to this and the manner in which education at large has increasingly become a technical activity to realize instrumental ends, the relationship between science educator and student of science is explored through the lens of physis, the Greek word for nature. Features of physis--nuance and the sojourn--experienced through existential wanderings within an old growth forest, are used to explore the nature of the teaching and learning dynamic around such dualisms as knowledge and mystery. Methodologically informed by interpretive inquiry (Darroch & Silvers, 1982), a composite of ontological hermeneutics and phenomenology, direct and immediate field experiences within a forest are used to illustrate the interpretive and analytical processes. The dynamic sway of physis demonstrates that educating within science can be a relationship where knowledge and mystery are each embraced by teacher and learner. Such a pedagogical stance reveals that curiosity, receptivity, wonder, awe, and altruism, typically subverted aspects of being, can be revealed through the relationship and dynamic of educating within science. The metaphor of physis helps placate our ontological, social and environmental displacements.

Sheraton New Orleans Hotel • New Orleans, LA

Alexander Kauertz Hans Fischer

Developing and evaluating a proposed model for increasing the validity of tests P-433-770-769-804

Since assessment tools such as tests are basic instruments for research in science education, increasing their validity is an important concern. This contribution suggests a method that can help to increase the validity of tests in general. The development of such a method first requires a model of item difficulty. We will discuss the criteria used to judge the model as well as our reasons for making those assumptions. The model is applied to an assessment of physics knowledge of upper secondary students. The quality of the test is measured and the reliability, validity and objectivity of the item development are discussed in order to interpret the results with more confidence. Validity and significance of the model are shown by various statistical methods. Examples for further use of the method are also presented. The findings of this study show that complexity of the subject matter is the most significant factor affecting item difficulty. However, this factor is moderated by basic concepts and cognitive demands when solving an item.

Sibel Kaya Cynthia Lundeen

Joining Forces: Recruiting Parent and Preservice Teacher Support and Involvement in Elementary School Science Partnerships Q-631-1216-1215-1248

This paper focuses on the implementation of a school professional development Family Science Initiative for the overall purpose of promoting positive attitudes and recruiting interest and involvement in teaching and learning science in the elementary school. The formation of a school/university science partnership provided the context for this study. University preservice teacher groups (n=88) and elementary school parent groups (n=75) were targeted as critical to successful and substantive support for elementary science teaching. Evaluation procedures included surveys,

Mahsa KazempourAidin AmirshokoohiWilliam HarwoodIntegrated Freshman Learning Experience: Reform-Based Teaching in an Undergraduate Biology CourseP-626-1279-1278-1310

This study is part of an ongoing research project investigating the experiences of undergraduate students who enroll in a special integrated inquiry-based biology program during their freshman year. The purpose of this particular study was to explore students' perspective on the program and their perceptions of science and science inquiry. Five students from the first cohort of students enrolled in the program were interviewed at the end of their second year and 17 students from the second cohort were interviewed at the beginning and end of their first year. The interview protocol asked students questions about how the program differed from their other science courses, what they learned about science as a result of enrolling in the program, and how the program prepared them for future science courses and research. Students had an overwhelming positive experience in the program and viewed it as a more effective way to learn science and an excellent preparation for future science endeavors.

Diane Ketelhut

The Impact of Student Self-Efficacy on Scientific Inquiry Skills P-198-327-326-363

This exploratory study investigated data-gathering behaviors exhibited by 96 seventh-grade students as they participated in a scientific inquiry-based curriculum project, delivered by a multi-user virtual environment (MUVE). I examined the relationship between students' self- efficacy on entry into the authentic scientific activity and the data-gathering behaviors they employed while engaged in that process, over time. Three waves of student behavior data were gathered from a server-side database that recorded all student activity while engaged with the MUVE, and were analyzed with individual growth modeling. I found that self-efficacy played a role in the number of data-gathering behaviors students engaged in initially, with high self-efficacy students engaging in more data gathering than students with low self-efficacy. Moreover, the impact of student self-efficacy on rate of change in data gathering. In addition, students' level of self-efficacy did not affect how many different sources from which they chose to gather data. There are indications in my results that embedding science inquiry curricula in novel platforms like a Multi-user Virtual Environment might act as a catalyst for change in student learning.

Claudia Khourey-Bowers

Christopher Fenk

Influence of Chemistry Professional Development Program on Chemistry Content Knowledge P-232-999-998-1032

Strong disciplinary content knowledge has been recognized as an essential component of effective teaching and has become a critical goal of effective professional development (PD). One goal of chemistry content instruction should be progression from personal mental models to abstract models consistent with scientific ways of thinking. Two research questions guided this study. Can inquirybased PD designed to provide fundamental content knowledge for teachers with little or no formal academic background enhance content knowledge of inservice teachers with varying degrees of prior content knowledge? Can inquiry- based PD expand representational thinking of inservice teachers with varying degrees of prior content knowledge? Chemistry knowledge of teachers was assessed using an 11-item test at the beginning and end of PD. Teachers showed significant growth at the p < .05 level, with 'elementary' posttest scores slightly less than the pretest scores for 'others.' This result suggests that PD designed for beginning learners in chemistry can result in learners at intermediate stages advancing in content knowledge. Growth in postest scores indicated that elementary and 'other' teachers made significant gains in macroscopic, microscopic, and symbolic models of thinking. Significant gain in total number of items was greater for 'others' than for elementary teachers.

Corinna Kieren Elke Sumfleth

Homework in chemistry education at the end of secondary school Q-554-1037-1036-1070

Under certain conditions homework studies show positive effects on students' cognitive achievement. With respect to chemistry education, different types of homework like, for example, experimental tasks or laboratory reports can be introduced apart from regular homework practice. The goal of this research project of this research project is to collect and analyse data on current homework practice in German chemistry education as well as on the significance of homework in German secondary schools. Therefore teachers of 10th-grade students in German secondary schools are questioned. The data collection takes place in Baden-Wuerttemberg, Schleswig-Holstein - both with PISA peak values - and North Rhine-Westphalia, for which the PISA data points out significant differences with regard to the duration of homework. With reference to the standards of optimal homework which have been worked out in research so far actual homework practice will be categorised (e.g. regarding the frequency, the length, the kind of setting and the complexity of tasks of chemistry homework). Through the formation of extreme groups (optimal homework versus dysfunctional and no homework) an intervention study is planned in order to make predictions whether modifying the 'homework design' results in higher learning outcomes in chemistry education. Furthermore, possibilities of improvement are offered.

Tuqqasie KillikteeAnuru WoodBrian LewthwaiteScience Education in Inuit and Maori Communities: Perceived Contributors and Constraints to AchievingAspirationsP-242-400-399-436

This paper reports on the first phase of a multiphase indigenous science education development project in Inuit communities in the northern Qikiqtani Region of Nunavut, Canada and Maori-medium kura (schools) in Aoteoroa-New Zealand. The development project in its entirety employs an action research methodology and by so doing endeavors to support the improvement of science education delivery in accordance with school community aspirations. The project focuses on (1) establishing the current situation in Kindergarten to Grade 8 science education in the communities; (2) identifying developmental aspirations for stakeholders within the communities and potential contributors and constraints to these aspirations; (3) implementing mechanisms for achieving identified aspirations; and finally, (4) evaluating the effectiveness of such mechanisms. This paper focuses on the initial phase of the development project; evaluating the current situation in Year 1 to Year 8 science education and identifying the developmental aspirations and perceived constraints and contributors for achieving these science education aspirations within these communities.

Donna King

Implementing a Context-based Approach in a Chemistry class: Successes and Dilemmas P-767-1650-1647-1677

The mandated chemistry curriculum in Grades 11 and 12 in Queensland Australia features a contextbased approach. This represents a radical pedagogical change from previous programs that emphasized conceptual development. Yet few studies have provided insightful interpretive accounts of how teachers implement a context-based approach. The purpose of this semester- long case study was to conduct a penetrating analysis of how a context-based unit on water was implemented in one Grade 11 Chemistry class in a boys high school in Brisbane, Australia. Data sources included interviews with the teacher and selected students, videos of classroom transactions including individual monitoring of two selected groups of boys and content analysis of project work with students. The study showed that firstly, the teacher used the real-life application (context) as central to the teaching of the content; secondly, that the content was taught on a need-to-know basis; and thirdly, while students and teacher indicated they were developing expertise in scientific processes, the teacher perceived her students experienced difficulties in deep understanding of the concepts during the context-based activities. This study suggests that it takes time to bring about pedagogical change in classrooms and that teachers are likely to struggle with the shift from a content laden traditional approach to the new context-based approach.

Amanda KingGail JonesBethany BroadwellAmy TaylorVisual Impaired Students Rationales of Scale and ScalingP-303-514-513-550

This exploratory study examined students with visual impairment's concepts of scale and scaling with written assessments and interviews. The multi- dimensional scaling analysis showed that majority of the students categorized the sizes of different objects based on the measurement of a five-year old child. Interviews revealed that students conceptualized the sizes of objects by comparing objects to their body size, their cane, and pace distance. Students described how they were taught about the sizes of things and scale. Most students reported that they learned the sizes of things primarily through auditory books and hands-on experiences. However, 40% of the students noted that they had difficulty accessing Braille books and other resources to learn science. The role of vision, haptics (touch and kinesthetics), and auditory sensory experiences are explored.

Heather King Lynn Tran

Proposing a pedagogy for science museum education P-438-804-803-838

Museum educators have had a long-standing presence in museums, but only limited attention has been paid to their practice and pedagogy. Whilst much can be gained from an understanding of teaching and learning in schools, a model of museum practice, which acknowledges the parameters of the museum environment, is necessary. Following a review of the literature, focus group discussions with museum educators and detailed analysis of their actions, a model of pedagogy was developed. This model proposes that the specialist knowledge and skills of science museum educators embodies education about science, as mediated through objects, fostered by talk, and supported by exploration in a free-choice environment. Building on the work of Shulman (1987), it is noted that museum educators employ a particular expertise which we term museum pedagogic content knowledge (mus-PCK). In explicating a pedagogical practice for museum educators, we offer a theoretical basis for a consistent in-service practice, and shared preservice training across the museum education field.

Susan Kirch

Talking Science: Patterns of inquiry in an elementary school classroom P-443-791-790-825

Educators and researchers are convinced that age limits what science students can learn. In this article, I discuss how young students are routinely and inappropriately restricted to decontextualized and disconnected experiences in science. Elementary school curricula focus on process skills under the faulty assumption that young students are not capable of combining the process skills and content knowledge necessary for reasoning scientifically. I have initiated a longitudinal ethnography to examine the learning pathways student take in science. I find that students as young as 7 years of age are capable of performing the most important elements of the professional practice of science including: designing a fair test, communicating results and procedures, and critiquing the hypotheses and findings of others. In this paper I present evidence from a pilot study where I used discourse analysis to examine what young students were attuned to in the world of scientific inquiry and how I, and my co-teacher, worked together to mediate this world for them.

James Kisiel

Science center visitor understanding of the science behind renewable energy *Q*-306-937-936-970

Although there is a considerable research base on misconceptions in science, there are few studies that examine people's prior knowledge of 'renewable energy' and the science concepts underlying such resources (e.g. solar energy, wind energy, fuel cells). Science center visitors were interviewed regarding their perceptions of renewable energy, including viability as an alterative to fossil fuels and potential benefits, as well as their understanding of related scientific concepts. While these lifelong learners struggled to explain how certain renewable energy resources worked (several misconceptions emerged), they generally had little trouble speculating on the viability of using such resources. Visitors tended to use evidence-based explanations (It's too cloudy here for it to work) or need-based explanations (We've got to use more alternatives to oil). In order to promote the use of renewable energy, or simply help learners better understand how renewable energy works, it will be necessary to confront, dismantle, or possibly build on some of the pre-existing explanations that drive visitor perceptions and decision-making. While these findings are quite valuable to exhibit developers in honing their educational message, they also shed some light on potential misconceptions related to the science behind renewable energy and provide direction for future research.

James Kisiel Leslie Edwards

Angela Calabrese Barton Na

Nancy Brickhouse

Tuxedo Junction: Improvisation with Formal and Informal Learning S-609-1469-1468-1499

In this symposium we propose an innovative discussion/debate format where two participants will present formal papers, two participants will be interactive discussants, and the audience will be encouraged to join the discussion. The discussants are familiar with the work of both paper authors and each has also designed and researched informal learning experiences so each discussant will provide examples from her own research. In other words, we are basically providing 4 case studies where the research findings argue with and support each other. In addition to the two formal papers prepared for this session and this symposium summary, we will distribute a set of 4 previously-published articles, one from each participant. They document each participant's previous research on various informal learning experiences. While these articles are not directly connected to the symposium discussion, we hope they will provide some background for why the intersection of formal and informal learning is currently so important and provide inspiration for future audience reflection.

Julie Kittleson

Practicing Epistemology in Science in an Elementary Classroom P-667-1500-1499-1530

This study was conducted to examine how elementary students practice epistemology during science learning activities. Examining practice highlights how epistemology is connected with the contexts in which it is used. Elementary students' practices provides insight into how they encounter the nature of knowledge during science investigations. These encounters provide resources for facilitating the development of ideas about science. Elementary students may interact with epistemology in unexpected ways. Therefore, practice may expand understandings of young children's ideas about science. This study took place in a third grade classroom in a suburban school. Data for this study were collected during the FOSS Human Body unit and a modified version of the STC Chemical Tests unit. Interview data and classroom data were the two primary data sources. One theme emerging via students' practices was the idea of science as a repertoire of tests, meaning that students indicated that certain tests were appropriate for certain situations. Additionally, findings from interviews indicate that students' practices during science learning activities influenced their ideas about science. In particular, the ways in which students practiced science investigations seemed to support the idea that learning science involves figuring out which tests should be used in particular situations.

Michael Klymkowsky

Conceptual interference in biological education: How jigsaw puzzle/lock and key models of molecular interactions impact understanding evolutionary change. *P*-269-1554-1553-1583

A practical goal in science education research is to identify where the teaching of one concept may impact student understanding of other concepts, presented subsequently. How student understanding of specific concepts interact with one another can be either constructive and reinforcing, or destructive and negating. In the course of research on students' conceptual landscapes as part of building a biology concept inventory, we have come upon an interesting example that illustrates this point. The way proteins in general and protein catalysts (enzymes) interact with their substrates and regulators is presented to students can lead to interference with an understanding of the mechanisms by which evolutionary processes can produce novel functions at the molecular level. We will illustrate this interaction and suggest approaches that may help address this particular issue, together with preliminary data on whether these interventions are effective.

Eun-Kyung Ko Byoung-Sug Kim

Are learners' views of nature of science content-dependent? A review of the research Q-452-808-807-842

The purpose of this paper is to review the literature on nature of science (NOS) to answer the question of whether learners' views of NOS are science content-independent or content-dependent. The literature on assessing and teaching NOS reveals that researchers have usually dealt with NOS in a content-independent manner. Most standardized instruments use content-free items to assess learners' views of NOS. With respect to content-embedded instruments, the science content within which NOS is addressed during the instruction is usually inconsistent with the science content embedded in assessment items. However, empirical findings from research on assessing NOS, research on the relationship between NOS and content knowledge, research on learning and teaching NOS challenge this assumption of NOS as content-independent. Learners' views of NOS vary among different knowledge domains and topics. The review implies that the assessment of NOS should separate the learning of NOS within given content from the transfer of NOS to other content. With respect to learning and teaching NOS, researchers should focus on both the nature of science in general and the nature of particular content knowledge.

Thomas Koballa

Development of a Questionnaire to Assess Conceptions of Science Teacher Mentoring Q-248-692-691-726

Recent research has identified three major conceptions of science teacher mentoring that guide the mentoring practices of beginning science teachers and the experienced science teachers who serve as their mentors. The purpose of this study was to develop a questionnaire to assess how strongly beginning teachers and mentors believe in each of these conceptions. First, 379 statements were gathered from a cohort of beginning and experienced science teachers about their mentoring practices. Next, these statements were organized into categories aligned with the major conceptions of personal support, apprenticeship, and co-learning. Then, statements that best represented the three conceptions, in terms of reliability and validity, were identified through statistical analyses of items and the judgments of experienced science educators. Finally, these best statements were used to construct the current 26-item Conceptions of Science Teacher Mentoring Questionnaire (CSTMQ). Use of the questionnaire could significantly improve the compatibility and effectiveness of mentoring pairings.

Jeanetta KochharJennifer CartierWendy SinkLetting the Cat Out of the Bag: A New Tool to Assess Curriculum MaterialsQ-721-1525-1524-1555

Elementary teachers are under increasing pressure to implement science curricula despite often having had inadequate preparation to do so (Koch, 2006). Perhaps consequently, they often rely heavily on prepared instructional materials to design and deliver science instruction (Keith, 1981; Ball and Cohen, 1996). Given the role that instructional materials play in the elementary science curriculum, it is crucial for researchers to understand the factors that impact teachers' enactment of such materials. In order to understand teachers' choices in curriculum implementation one must know what the curriculum offers to teachers in the way of support. This paper describes the Curriculum Assessment Tool, an instrument developed to examine instructional materials through the lens of the (Big Ideas, Tools, and Talk) model (Cartier, 2005). The BITT model was designed to promote active participation with materials to achieve effective implementation, therefore it is necessary to know what support is contained within curriculum materials. CAT allows documentation and assessment of support provided in curriculum materials. We used CAT to assess FOSS kits to better understand teacher implementation of the BITT model during a 2 year professional development study. We found that, as written, FOSS does not offer sufficient support for teachers to effectively implement BITT.

Catherine Koehler David Moss

The Nexus between Science Literacy & Technical Literacy: A State by State Analysis of Engineering Content in State Science Frameworks 0-687-1466-1465-1496

Technical literacy is the ability of an individual to make informed decisions based regarding their understandings of modern technologies. The Engineering Education Frameworks (EEF) was proposed to define a pathway toward promoting technical literacy for high school students. These frameworks were designed to facilitate the teaching of multiple science disciplines in concert with mathematics while incorporating engineering concepts and designs. The intense review of 49 state science frameworks, including the District of Columbia and the ITEA standards, addresses the question: How do state science frameworks incorporate engineering concepts into their secondary science curricula? The findings indicate that many states include various aspects of EEF content standards and widely use the term technology, but fail to identify the context of engineering concepts as it relates to the disciplines in science.

Michele Koomen

Listening to their voices: what are they telling us about their experience in learning using Inquiry? P-511-925-924-958

This paper reports on a phenomenological study of nine regular and special education students as they studied insect biology and ecology in their inclusive seventh grade life science class. Three fundamental data collection methods of qualitative research (student observations, interviews and artifact analysis) framed the data collection of this study. Hermeneutic phenomenological analysis (Van Manen, 1990) and the seven-step framework from Cohen, Manion, and Morrison (2000) were used to systematically analyze the data resulting in the emergence of four main themes. This paper will report on one theme: The practice of inquiry learning in science is fragile. Inquiry learning is fragile because surface reviews of the data reveal opportunities for inquiry learning through Problem of the Day (POD's) and formulating questions as the students' experience science. Below, the surface, the inquiry is fragile because students are focused on doing what their teacher tells them and finding the right answers to their questions so they can be done with their work and because of their views and perceptions of how we go about doing science. The potential impact and value of this study is that science teaching in inclusive classrooms may be better directed for students with disabilities.

Rekha Koul Darrell Fisher

Improved Science Assessments Using Student Perceptions P-238-394-393-430

This paper reports on part of a large three-stage study aimed at developing, validating and applying an instrument that can be used to assess secondary students' perceptions of assessment. In the first stage, following a review of literature, a six-scale instrument of 48 items was trialed with a sample of 470 lower high school students from 20 science classrooms. Based on internal consistency reliability data and exploratory factor analysis, refinement decisions resulted in a five-scale instrument that was named the Student Perceptions of Assessment Questionnaire (SPAQ). In the second stage, the SPAQ was used with five scales of the What is Happening in this Class (WIHIC) questionnaire, an attitude scale, and a self-efficacy scale. This survey was administered to a sample of nearly 1,000 students from 41 science classes from the same grades as in the first stage. In third stage teaching of exemplary teachers identified on the basis of student perceptions were observed.
Richard Kozoll

Identity Constructs amid Science, Teaching, and Self: Implication for Science Teacher Education P-36-640-639-676

The purpose of this study was to explore the identity construction of minority, secondary preservice science teachers through descriptions of their interest in science and science teaching. While their narratives with regard to science elicit particular self-understandings related to their raced, classed, and gendered identities they further translate into the qualities of self the participants find appropriate for enacting larger goals concerning the purposes of science education. As such the qualities of self they deem important for realizing these goals are facets of their identities, which they recognize and articulate against the backdrop of science teaching. Their stories, and the values they encompass, suggest the importance of exploring these same narrative understandings in light of what might be considered more contemporary science teacher education topics.

Joseph Krajcik Shawn Stevens

Introduction of Emerging Science into the Classroom- the Case of Nanoscience and Nanotechnology P-645-1340-1339-1371

This paper is an overview linking the 4 substantive papers (papers 2-5) in this related paper set. This set of papers deals with ways to incorporate emerging science into the middle and high school curriculum, using nanoscale science as an exemplar. In this session, we report on the diverse research that the National Center for Learning and Teaching Nanoscale Science and Engineering (NCLT) has undertaken to prepare for the introduction of nanoscience and nanotechnology into classrooms. Towards student learning, we describe in detail the motivation potential of nanoscience phenomena and concepts, and discuss the development of students' understanding of size and scale. We discuss the development and validation of a learning progression for student understanding of the nature of matter. Lastly, we report on strategies for designing professional development for an emerging science such as nanoscience and nanotechnology.

Gerald Krockover Loran Carleton

Changes in Teachers' Context Beliefs about Teaching Science During a Year Long In-Service Teacher Education Program P-89-152-151-188

As a result of participating in a year long education program focusing on integrating constructivist and inquiry- based teaching techniques into the standards-driven classroom, science and mathematics teachers in grades four through nine showed increased positive beliefs about their teaching context as measured by the Context Beliefs about Teaching Science (CBATS) instrument. The program assisted them in changing their perceptions about the availability of teaching resources, but did not significantly change beliefs about the enabling power of these resources. Teachers expressed high enabling beliefs about factors such as 'hands-on science supplies' and 'permanent science equipment' and low enabling beliefs about factors such 'involvement in the state board of education.' After completing the program, teachers believed more strongly in the availability of support from their administration.

Tussatrin KruatongAlister JonesSunan Sung-ongPenchantr SinghDevelopment of High School StudentsUnderstanding of Heat and Thermodynamics Concepts through AContextual ApproachP-437-1002-1001-1035

The prior study revealed that most of 214 high school students held alternative conceptions of heat and thermodynamics. To enhance student understandings, students should be presented with heat and thermodynamics concepts along with thermal situations and identifies contrasts and comparisons between them. Based on this idea, the series of heat and thermodynamics learning unit (HTLU) were developed by using multi-context through the diversity learning strategies which aimed to restructure the alternative conceptions and motivate learning actively. A key element of this approach is using a particular situation as a learning context driving a scientific concept and one or two more situations as a transferring concept to new context at the end of the lesson. The HTLU consists of 13 lessons which were trialed in three schools by three volunteer teachers during November 2005 to February 2006. The results from observations, interviews and questionnaires revealed that the HTLU has the advantage of providing more practices for students to understand and make the links across different contexts. Most of students favorably responded to the unit and involved more in the lessons by sharing ideas and carrying out their own investigations. Students found the lessons were interesting, easier to understand and relevant to everyday life.

Leema Kuhn Brian Reiser

Bridging Classroom Practices: Traditional and Argumentative Discourse P-718-1522-1521-1552

Scientific argumentation is increasingly seen as an important aspect of science education (e.g. Driver et al., 2000). This practice requires that students engage in substantive conversations with one another, determining whether and why they agree with claims and whether the evidence supports those claims. How do we alter traditional classroom interactions to motivate and enable students to engage with one another's ideas through scientific argumentation? This paper addresses this question by analyzing two days of instruction in a single classroom. The first represents traditional classroom interactions while the second depicts students engaging in scientific argumentation. Comparing these contrasting cases within a single classroom allows us to focus on the aspects of the classroom environment that change. Thus, we use these examples to elucidate aspects of the classroom environment that help to enable student participation in scientific argumentation: 1) encouraging multiple answers 2) goals of the activity structure and 3) student and teacher roles. We contend that while we designed the activity structure to foster argumentation this teacher made our activity meaningful, thereby enabling argumentation, through these aspects of the classroom environment.

Pi-Chu Kuo

Teaching strategies in a science camp for ESL students: A case study P-633-1222-1221-1254

The purpose of this study was to reveal the teaching strategies implemented in an environmental science camp. The particularity of the students in the environmental science camp increased the difficulties in teaching. The teachers had to adjust and decide their teaching strategies after they met the students. This study investigated what and why teaching strategies the teachers used and how the student responded. The participants were two American science teachers and 18 Taiwanese high school students in the environmental science camp. Data were collected from interviews with the two teachers, observations from the fieldwork and video records. Teaching strategies including cooperative learning, demonstration, field trip, game, inquiry, lecture, museum education, peer coaching, presentation, project- based learning, and heterogeneous student grouping were identified. Various teaching strategies were used to reduce the difficulty in teaching and learning because of the diversity, especially in student English proficiency. Proper teaching strategies and teachers' enthusiasm obtained positive feedbacks from the students in spite of language barrier. This can serve as a feasible teaching module for teaching and learning in a science classroom with diversity issue.

NARST Annual International Conference 2007

Jenny Kwan Alice Wong

Interactive relationships among teachers intentions, beliefs, pedagogical content knowledge and classroom instruction on the nature of science P-299-507-506-543

The purpose of this study was to investigate the relationship among teachers' intentions, beliefs, pedagogical content knowledge (PCK) and their classroom practice, and to delineate factors that cause changes in teachers' intentions, beliefs and PCK. Four in-service secondary science teachers comprised the sample for this study. Throughout the academic year, data sources including classroom observations, pre- and post-lesson discussions, instructional materials, students' works and questionnaires that measured teachers' understanding of NOS were collected. Preliminary result of Tammy, a beginning teacher, indicated that there were interactive relationships among her intention, beliefs, PCK and classroom practice. Having started to teach NOS, Tammy gained better understanding of NOS while developing her PCK. Tammy's experience of teaching NOS demonstrated a positive feedback effect of classroom practice on cultivating teachers' intentions and beliefs. The result of another teacher, Kevin, demonstrated the strong influence of teachers' existing beliefs on the translation of teachers' understanding of NOS into classroom practice, and revealed a need for change in examinations that is coherent with the educational objective of helping students develop an adequate understanding of NOS.

Peter LabudeReinders DuitBirte KnierimBernhard GerberVideo-based analyses of German and Swiss introductory physics instructiondominating instructionalpatterns and teachersviewsP-140-753-752-787

In a bi-national video study instructional patterns in German and Swiss classes (grade 9) were analyzed. 90 teachers and about 1900 students participated. Two physics lessons of each teacher were video taped, transcribed and coded. The topic of the lessons was either introduction into the force concept or into geometrical optics. The coding systems focus on classroom activities in general, on kinds of group work, experiments and sequencing of content. Additional data are provided by student and teacher questionnaires and by teacher interviews. The results yield a detailed description of 'normal' physics instruction in Germany and Switzerland. In both countries, for instance, experiments play an important role. Two-thirds of the instructional time are used for introducing the idea of the experiment and to plan it, to actually carrying it out and to discuss the results, either demonstrations or practical work. In Germany significantly more often whole class discussions occur than in Switzerland. Swiss teachers are more likely to use group work and practical activities with a higher degree of openness than German teachers.- It appears that the kind of studies as presented can provide deep insights into normal instructional practice.

Barbara Ladewski Joseph Krajcik Annemarie Palincsar

Exploring the role of inquiry and reflection in shared sense-making in an inquiry-based science classroom *P*-740-1578-1577-1607

Despite considerable attention to inquiry and reflection in the literatures of science education and teacher education/professional development over the past century, few theoretical or analytical tools exist to compare/ contrast these processes, or to characterize their development, within a naturalistic classroom context. In the current research study, we develop a model of shared sense-making that attempts to integrate processes of inquiry and reflection, and systems of shared sense-making and mental models of those systems, into a single coherent framework. Using the model of shared sense-making as an interpretive frame, we develop a qualitative case study that explores teacher-student shared sense-making over the course of a year of scaffolded introduction to inquiry-based science instruction. Findings suggest that conceptualizing inquiry and reflection as two interactive coherence processes within a model of shared sense-making provides a rich interpretive framework for exploring teacher-student interactions in the classroom. Findings further suggest that perspectival shifts play an important role in developing shared sense- making and that human sense-making systems and human mental models of sense-making rather than individual teacher activity or student learning has important implications for both science education and teacher education/professional development.

Sheraton New Orleans Hotel • New Orleans, LA

Anne Laius Miia Rannikmäe

Exploring students socio-scientific argumentation and creative thinking skills in Estonian 9th grade science classes

Q-625-1307-1306-1338

This paper reports on a methodological approach to the analysis of argumentation nd creative thinking skills in Estonian primary school science classes developed as part of the project The development of students' creative and critical thinking through real-life situations in science classes . The sample was formed from 266 nine grade students in 7 different schools and their 14 science (mostly biology and chemistry) teachers. Three different real-life situations were used to investigate the argumentation skills of students and their teachers, based on Toulmin's argument pattern. An instrument of discrepant situation was used to assess the students' creativity, based on three activities: asking questions, suggesting causes and the predicting consequences. According to the results, the students' and teachers' argumentation depended on the theme of real-life situation. The level of argumentation did not exceed the third level on Toulmin's scale of five. There occurred some significant differences between students' and teachers' choices of different types and quality of argumentation. The significant correlations occurred between the students' quality of argumentation skills and the quality of their creative thinking skills and the female students' exceeded the male students' results of argumentation and creative thinking skills.

Julie LambertGeorge DeBoerPreservice Teachers Ideas on the Theory of Global WarmingP-748-1591-1590-1620

This study examined preservice students' knowledge of basic concepts (i.e. photosynthesis, respiration, etc.) that would be required to have a deeper understanding of the theory of global warming. Patterns emerged from analysis of the pre and post assessment responses related to seasons and climate change. Most students on the pre-assessment chose the correct response that the tilt of Earth as it revolves around the sun is the cause of the seasons. Very few students were able to correctly choose a diagram to illustrate this concept. On the post-assessment, most students were able to choose the correct diagram. Many students did not know the basic processes of photosynthesis and respiration on the pre-assessment. A majority of students on the pre- assessment knew the partially correct possible consequences of global warming, but many thought the cause was related to the hole in the ozone layer. They could not distinguish between the greenhouse effect and global warming. Students showed significant improvement in their understanding on the post- assessment.

Carolyn Landel

Building a Partnership to Advance Reform of Science Teaching and Learning in Higher Education P-288-478-477-514

One product of the North Cascades and Olympic Science Partnership is a year-long science course sequence developed and implemented consistent with research on how people learn. The sequence targets the needs of preservice elementary teachers, but has been taught to general undergraduate students and inservice teachers as well. This related paper set will address the development, implementation, and outcomes of these courses in both inservice and preservice settings. In particular, this first paper of the set describes how a partnership between five regional institutions of higher education to design and implement these courses has contributed to faculty and institutional change.

Kimberly Lebak

Connecting Science Field Trips to Classroom Learning P-197-550-549-586

This research focuses on improving the teaching and learning of science for teachers and students participating in outdoor field trips. Participants in this research included three classroom teachers, their students, and me as a teacher-researcher. The research was situated in the science classroom of three teachers representing schools with diverse socioeconomic factors and diverse student populations and The Outdoor Classroom, an informal learning center. This study addresses fundamental questions regarding science learning in an informal setting. This study examines how the activity structures at an informal learning center support or contradict the classroom activity structure and how cogenerative dialogues (Roth & Tobin, 2002) between instructional stakeholders can serve as a catalyst to change structures in order to maximize the potential learning opportunities at informal learning centers. This research provides evidence of the ways the informal learning field is shaped by participating teachers' and students' cultural, historical, and social factors and how these factors create borders for the participation and learning of science at The Outdoor Classroom. The implications for informal science teachers and classroom teachers is to communicate goals, acknowledge cultural barriers, and allow for coteaching opportunities that promote positive interaction rituals for both teachers and students during field trips.

Norman LedermanPer-Olof WickmanJudith LedermanAnders TeleniusAn International, Systematic Investigation of the Relative Effects of Inquiry and Direct InstructionP-229-376-375-412

An International, Systematic Investigation of the Relative Effects of Inquiry and Direct Instruction The purpose of this investigation was to systematically study the relative effects of direct instruction, inquiryoriented instruction, and a mixture of the two approaches with eight grade science students. The design involved an international collaboration between the Illinois Institute of Technology and the Stockholm Institute of Education so that the findings would be more globally generalizable. The results do not support the current contention that direct instruction is superior to inquiry-oriented instruction. With respect to subject matter knowledge, there was no difference, but there was a significant difference with respect to attitudes toward science and knowledge of inquiry in favor of the inquiry-oriented group. The mixed instructional approach was superior to direct instruction with respect to all three outcome variables. Interestingly, however, the mixed instructional approach was superior to the inquiry-oriented approach with respect to subject matter knowledge. As we have learned in the past, moderation in instructional approaches tends to be more effective than extreme approaches of any type. Given the findings regarding the mixed instructional approach, perhaps our research questions concerning instructional approaches needs to abandon unrealistic and inappropriate dichotomies.

Eunmi Lee

The Roles of Curriculum Materials in Instructional Decision Making Process P-103-1318-1317-1349

Pedagogical content knowledge (PCK) is an integration of the knowledge of pedagogy, content, learning, and students, thus acting on the instructional decision making process. It is generally accepted that PCK plays a major role in the way any curriculum is enacted. However, it is not clear to which degree a teacher's interaction with new curriculum materials especially those that are intended to foster effective inquiry-based science teaching and learning contributes to the construction and reconstruction of that teacher's PCK. With regard to this stated problem, the goal of this study is to describe a middle school science teacher's implementation of new curriculum materials. This study, which focuses on unpacking the curriculum implementation process in which instructional strategies are adopted, adapted, enacted, and evaluated, can illuminate the role of curriculum materials as tools to support for constructing and reconstructing a teacher's PCK. Data for the study come from semi-structured interviews, class observations, classroom videos and other associated documents. The results of this study report the roles of curriculum materials in a teacher's instructional decision making process and discuss the implications of the findings in designing of curriculum materials as tools for supporting a teacher's PCK.

Sheraton New Orleans Hotel • New Orleans, LA

Hyunju Lee Klaus Witz

Science Teachers' Inspiration for Teaching SSI: A Gap With Reform Efforts P-256-423-422-459

The need for the inclusion of SSI into science curricula is generally accepted, but relatively few science teachers have incorporated SSI into their courses. Most science teachers feel that their main task by far is to teach the principles of science, and any substantive pedagogical changes represent a burden. Reformers and researchers often point to science teachers' passive reactions to reforms as a major barrier to educational change and so pay little attention to teachers' deeper values and inspirations. However, there are some teachers who are addressing SSI through personal initiative. By presenting detailed case studies of four teachers who are actively teaching SSI, this study discusses a phenomenon that shows that such teachers' inspirations for teaching SSI are not closely connected with the current reform efforts. Basically, they had chosen to teach SSI on their own, following their own values, ideals, philosophies, or personal concerns. This suggests that the current curriculum reforms (STS, SSI, and NOS) only suggest theoretical ideals and do not effectively touch teachers' deeper values and ideals. In addition, real changes in science education can be achieved only if they are synchronized with individual teachers' deeper motivations.

Sung-Tao LeeHuann-Shyang LinJeng-Fung HungThe Study of the Mechanism of Primary Science Teachers Teaching Decisions in Taiwan : a groundedperspective of GEAR modelP-424-752-751-786

The purpose of this study is to explore primary science teachers' teaching decisions and related decision making mechanism under the national science educational reform calls in Taiwan. By focusing on two case teachers of different developmental stages, the researchers combined case teachers' paradigmatic and narrative modes of thoughts with related theories prevailing in the field of decision science to collect empirical data from teachers' argumentations and narratives regarding their teaching practices within six months. After the analysis of collected quantitative and qualitative data, a science teaching decision making mechanism called GEAR model (Goal-Epistemology-Action-Resource) was constructed to illustrate case teachers' thought processes in their science teaching decisions. In this model, two case teachers revealed different operations of these four parts and caused different teaching patterns in their classrooms in which one was more stable and inquiry-oriented and the other one was adjusted to different units and more inclined to traditional teaching of science conceptions prescribed in the textbook. It is indicated that this integrated perspective of science teaching decision can be referential to researchers interested in science teachers thinking in the context of current science educational reforms.

Huei LeeJen-min ChangChiung-Fen YenAlternative Conceptions of Burning: A Study of the Worldview of Atayal Aboriginal Students in TaiwanP-729-1526-1525-1556

The purpose of this study is to investigate the alternative conceptions on the phenomenon of burning for Atayal aboriginal primary school students in Taiwan. The study was conducted in two stages. In the first stage, three Atayal elders were interviewed. Then an open-ended questionnaire was administered to 37 students from the third to sixth grade. Eight of these students were interviewed in the second stage, a two-tier diagnostic assessment was administered to 228 aboriginal students from the third to sixth grade, and 44 of them were subsequently interviewed. Our results showed that aboriginal students have many alternative conceptions on five topics related to burning, including candle burning', factors affecting burning', fire extinguishing', material changes through burning', and the traditional and cultural meanings of fire'. One of the most unique findings of this study, in view of past studies, is the student perception that people should not come in close proximity to a fire alongside a sick person since diseases may be transmitted through fire. Factors affecting these alternative conceptions included culture, environment, economy, medicine and hygiene, and personal thinking.

Eunmi Lee Matthew Rossi

Middle School Students Understanding of Convection as a Causal Mechanism for Generating Winds Q-103-1599-1598-1628

The purpose of this study is to identify and characterize different types of students' understanding about convection currents as a causal mechanism for generating winds, and the conceptual changes derived from instruction. Instruction, including two concrete phenomenological experiences, a conceptual model construction activity and group discussion, was provided in order to promote a richer understanding of convection currents. We then examined the students' conceptual progression of applying convection currents (a scientific principle) to explain winds (a scientific phenomenon). The data come from two middle school science classrooms (n=45), including pre- and post-tests, classroom video, students' activity books and artifacts. The findings of this study include a survey of students' preconceptions, misconceptions and procedural errors associated with applying their understanding of convection currents to explain winds, and the effects of instruction. It is hoped that this will provide further insight into both the nature of students' science learning and the development of effective instructional strategies for activities and lessons related to convection currents and winds.

Ed Lehner Ed Kagen

Cogenerative Dialogue as an Effective Teaching Tool: A Pilot Study with At-risk Students Teaching Science in an Urban Environment P-132-1226-1225-1257

A quasi-experimental pilot study was conducted at a New York City Suspension Center with highly at-risk students to determine if cogenerative dialogue would be a viable way of enhancing classroom attitudes and achievement in a high risk population learning biology. The study was one of the first to use quantitative measures to consider this issue. The data showed that the cogenerative dialogue process had significant effects on both classroom attitude and achievement.

Nina Leonhardt

Expanding Professional Development to the Community: P-356-849-848-883

The purpose of this study was to determine if NYC science teachers professional development experiences as part of their NYU graduate program could have an expansive impact on their teaching, learning and personal communities. As participants in our Sharing Our Success (SOS) conference, the teachers presented their action research and curricula strategies on a national stage. The conference, therefore, empowered the teacher presenters who became teacher leaders in their schools and communities. Expanding from a base of six (6) NYU student presenters in 2000, our 2006 conference featured over 25 of our current and former students, with many returning each year. Using case studies based on presentations, biographies and interviews, we traced the professional growth of four (4) MSTEP SOS presenters. Today, our four case studies have moved from the classroom to teacher-leaders and policy makers, where they positively affect science education for teachers and students in their New York City region. For those that return to SOS every year, they cite a desire to give back. This recurrent theme amongst MSTEP/SOS presenters implies that the effects of the program and the conference have extensive and expansive impact

Mary Leonard

What's the Science Behind it? Students' Models of Motion in a Design-for-Science Classroom P-461-827-826-861

Educational researchers, curriculum developers, and educators have been increasingly drawn to engineeringtype design activities as a means of providing students real-world contexts for learning science concepts. Such design activities are used to scaffold science learning as well as support general education goals such as problem solving and working in teams. While engineering and science are deeply interrelated fields, they have epistemological differences in their goals and knowledge that make design not a 'plug and play' environment for science learning. In light of educators', researchers', and curriculum developers' interest in design-based contexts for science instruction, it is important to improve our understanding of how to support learning science in the context of design. This study investigated how an enacted design-for-science activity afforded and constrained development of science conceptual knowledge. Analysis focused on how students' expressed models of balloon car motion accommodated the science explanation provided in the teacher's force lecture. The analysis showed the lecture was at least partially successful in moving students' conceptual models toward the accepted science explanation. The study contributes a description of students' conceptual models of motion in a design-for-science context and an epistemological framework as a perspective for analyzing and understanding the challenges of such classrooms.

Elizabeth Lewis Sibel Uysal

Small Group Reflections of Secondary and Post-Secondary Science and Language Arts and ELL Faculty upon their CISIP Professional Development Experiences P-308-540-539-576

Abstract This study summarizes semi-structured focus group exit interviews with Communication in Science Inquiry Project (CISIP) participants, experienced secondary and post- secondary science, English, and ELL faculty, after three weeks of summer professional development. CISIP is an NSF- funded initiative designed to meet the need for highly qualified teachers and science education reform. The main purpose of the larger study was to understand teachers application, in teams, of the CISIP model during the summer institute. The purpose of the focus group interviews was to triangulate researchers observations with the participants perceptions. Participants expressed favorable attitudes toward their extended CISIP experience, which included at least one year of participation leading up to the summer institute. All acknowledged the value of teamwork to create interdisciplinary curricula and learn the CISIP model. Science educators valued sharing ideas with other teachers and disciplinary area experts (language arts and ESL) to improve their own understanding and classroom practice of how to incorporate academic and English language acquisition, oral and written discourse teaching strategies into their inquiry-based science lessons. By providing an explicitly adaptable curriculum model, facilitators can empower individual educators to assess, design, and enact effective pedagogy and curriculum to meet the needs of their own unique students.

Karaen Levitt Barabara Manner

Adria Scott

Teachers-in-Residence: Ongoing Professional Development for Elementary Teachers of Science P-270-1443-1442-1474

Teachers-in-Residence (TIR), master teachers with extensive experience in teaching in basic education, can play a significant role in the preparation of elementary science teachers. While previous studies examined the impact of the TIR on the educational organization, little attention has been paid to the impact of these experiences on the teacher in residence. At Duquesne University, the TIR works as part of a team in the Early Childhood and Elementary teacher education program, specifically teaching in the course, Educated Citizenry, which integrates science, social studies and the arts using an inquiry approach. The primary question explored in this research was, what is the impact of serving as a Teacher-in-Residence on the classroom teacher? Using multiple data sources, each of the TIR related that the most significant benefit was the professional growth and development that they experienced by keeping current on effective practices. As schools change, teachers must continually renew their professional knowledge and skills to meet the needs of all learners. Research based programs such as the Teacher-in-Residence can serve as ongoing professional development for strengthening the skills and knowledge of classroom teachers to impact the students they teach.

NARST Annual International Conference 2007

Abigail Levy Daphne Minner Erica Jablonski

Inquiry-based science instruction and students' science content knowledge: A research synthesis P-372-656-655-690

This paper describes the findings from a synthesis of research that addressed the research question: What is the impact of inquiry science instruction on student outcomes compared with the impact of other instructional strategies and approaches? Of the 138 studies included in the analysis, 105 were conducted in the United States; 42 focused on elementary; 49 on middle; and 47 on high school grades. Studies were completed between 1984 and 2002; examined students' science content knowledge relative to physical, life, and earth/space science; and employed a variety of research designs and methodologies. The paper discusses in detail the nature of student outcomes across and within science disciplines, grade levels, and research designs, including both comparative and non-comparative studies using quantitative, qualitative, and mixed methods. The nature of inquiry instruction, and 'inquiry saturation' are also discussed.

Julie Scheneider

Min LiMaria Ruiz-PrimoShinping TsaiExploring Teachers' Feedback in Student Science NotebooksP-742-1583-1582-1612

The success of science education reform relies on the quality of teaching that takes place in the classroom; students' opportunities to learn science should be appropriate, meaningful, and rich (see National Science Education Standards/NRC, 1996). We think that measuring the quality of teaching leads not only to more valid interpretations of students' scores but to more concrete suggestions for improving students' learning. In this paper, we use science notebooks as a source of information to evaluate one aspect of instruction - teacher feedback. The premise is that science notebooks include student work that results from an assignment the teacher has given and reflects, somehow, the fruits of the teacher's instruction (cf. Warren Little, Gearhart, Curry, & Kafka, 2003). We maintain, then, that science notebooks reflect, at least partially, the instructional tasks carried out in a science class and can provide some evidence of teachers' communications with students about their progress. By analyzing student performance and teacher feedback found in student notebooks from twelve middle school science classrooms, we examined the type, quality, and characteristics of teacher feedback that students received. We found that high quality teacher feedback tended to be associated with increased learning outcomes indicated by multiple assessment methods.

Jyh-Chong LiangChin-Chung TsaiChun-Yen ChangThe development of science activities via on-line peer assessment: The role of scientific epistemological viewsP-456-822-821-856

This study utilized an on-line peer assessment system to help 38 students (who were preservice pre-school teachers) develop appropriate science activities for pre-school learners. First, the effects of the on-line peer assessment system on the students' science activity development were evaluated. Second, the role of students' Scientific Epistemological Views (SEVs) on their gains or development derived from the on-line peer assessment process was examined. The peer assessment was conducted in three rounds and took about two months. It was found that students significantly progressed their performance as a result of the on-line peer assessment process. That is, students significantly improved the design of their science activities as involving the peer assessment process. Moreover, by exploring the correlations between students' SEVs and their gains from the process of peer assessment, the results, in general, suggested that students with more constructivist-oriented SEVs might benefit more from the peer assessment process. This finding implies that an appropriate understanding about the constructivist epistemology may be a prerequisite for utilizing peer assessment learning activities in science education.

Xin Liang Sufian Forawi John Hirschbuhhl

Developing In-service Teachers' Scientific Ways of Knowing P-749-1592-1591-1621

For more than a decade, there has been a call for science education reform that emphasizes developing teachers' and their students' views related to the scientific ways of knowing. This idea stresses two major aspects, the nature of science and scientific inquiry approach. Part of the reform effort is to achieve scientific literacy. The purpose of the study was to examine in-service teachers' conceptions of the nature of science and inquiry teaching approach as they relate to the scientific ways of knowing. The study is based on a funded grant project that aimed to developing K-12 in-service teachers' scientific ways of knowing. 22 teachers were surveyed at the beginning of one- month intensive institute and at the end of that period using the Science Nature Survey (SNS) (Author, 2003). Observations based on teachers' inquiry activity checklists and responses to open-ended questions were noted and recorded. Statistical analysis revealed several t-test significant results indicating a change on teachers' scientific ways of knowing. Major qualitative results indicated participants' attributes of scientific ways of knowing.

Julie Libarkin Anila Asghar

Gravity, magnetism, and 'down': College student's conceptions of gravity P-623-1203-1202-1235

Conceptual understanding of gravity is vital for understanding of concepts in many scientific disciplines. In the geological sciences, gravity is integral to concepts such as mass wasting, water flow, and isostasy. While gravity conceptions of elementary-aged students are understood for a range of contexts, relatively few studies have focused on college student conceptions of gravity. In addition, gravity concepts held by students enrolled in science courses other than physics have never been investigated. This study utilizes techniques applied to the investigation of young children to characterize gravity conceptions held by students in entry-level college geology courses. Questionnaires collected from 216 students indicate that students hold a variety of gravity concepts, the vast majority of which are non-scientific. In particular, we find that gravitational attraction is confounded with magnetic attraction, orbital dynamics, and perceptions of the down direction. In addition, verbal explanations of the source of gravity are generally nebulous and related to the effects of gravity rather than its causes. Interestingly, college student conceptions are apparently quite similar to models held by young children, suggesting limited conceptual development about gravity with maturation and education. The implications of student gravity concepts are then considered in the context of non- physics courses.

Jing-Wen Lin Mei-Hung Chiu

Students Conceptial Evolution in Electricity an Emprical Validation of Cladistical Aprroach P-271-458-457-494

It is generally acknowledged that students' preconceptions are the central factors to influence science learning. Accordingly, the information about students' conceptions developmental pathway is helpful to frame the sequence of curriculum. However, the investigations of conceptions developmental pathway not only spend a lot of time and efforts, but also face the validation problem of research results. Therefore, the authors introduce the cladistical approach in biology to analyze the evolutionary process of pupils' mental models in electricity to solve these problems. Due to the approach is novel in science education, we deliberately accomplished four main stages to explore its feasibility. This study is the second stage. The major aim is promoting the cladistical approach in investigating students' conceptual developmental pathway and learning difficulties by empirical validation. Accordingly, this study adopted a set of diagnostic test items to 440 students from Grade3 to Grade9 to obtain the across graders percentages of students' cognitive characters and cognitive statuses. The authors tested the predictions of Tree 70 by comparing with the percentages investigation. From the empirical data, the results verified the feasibility of applying cladistics approach to science education.

Tzu-Chiang Lin Yeong-Jing Cheng

The Influence of Teaching with Situated Learning Rationale on 7th Graders' Learning in Biology P-373-659-658-693

In the present study, researchers were intended to figure out whether teaching with situated learning rationale benefited 7th graders' learning in biology. With a quasi-experimental design, students' achievement in biology and biology self-efficacy were compared between different teaching settings. Instead of conventional lectures in control group, the situated learning design emphasized participation in the social learning community within classroom. The results revealed that, in experimental group, those who had higher self-efficacy in biology before instruction had better learning outcome, but not in control group. The findings indicated that teaching with situated learning rationale has some extent of profit for biology learning indeed. Furthermore, in addition to learning environment, students' perception and behavior in biology learning also needed respecting more in teaching design.

Chia-Ching Lin Chin-Chung Tsai

Information commitments, scientific epistemological views and Internet-based science learning P-379-675-674-709

Early research suggested that epistemological criteria are important to judge the merits of online sources while executing searching processes for acquiring more accurate and usable information. However, as facing some particular information regarding scientific issues, learners might need more domain-related epistemological judgments to cope with the features of complexity and alteration in scientific knowledge. In this study, two self-reporting instruments including Information Commitments (ICs)' survey and Scientific epistemological Views (SEVs)' questionnaire were employed to assess students' evaluative standards for online information (called information commitments (ICs) in this study) as well as epistemological views toward scientific knowledge. Sixty-two high school students were chosen to answer two questionnaires and then perform an Internet- based search task about science. Students' responses of questionnaires were entered into regression model to predict their web-based task performance rated by trained researchers. The results of this study revealed that information commitments could predict students' science- related on-line searching task performance more directly than SEVs. However, further analysis by dummy regression models indicated that the interactions existed between students' ICs and SEVs, which may simultaneously impact their science-related searching task performance.

Jien-Liung LinTai-Chu HuangYuh-Yih WuThe Development and Validation of Web Project Based Learning Environment Instrument (WPBLEI)P-44-1098-1097-1131

The purpose of this study was to develop a web project based learning environment instrument (WPBLEI) as a tool to evaluate the project based e-learning environment. Data gathered from college classes using web project based instruction and there were two test samples, total 363 college students. According to the results of item analysis and exploratory factor analysis, the final version WPBLEI consisted 39 items. The Cronbach's alpha for the entire instrument was 0.971; for each scale, alpha ranged from 0.833 to 0.924. By utilizing confirmatory factor analysis to examine the measurement model, that goodness of fit was confirmed be acceptable. The content analysis of the open-end questions also showed a triangulation support to the 5 scales of the WPBLEI. In the validation process of this study, it is found that the integration scale is an important factor in web project based learning environment. The analysis results of the study confirm the validity and reliability of the WPBLEI instrument.

Show-Yu LinChih-Ming TuYeong-Jing ChengMiao-Li ChanglaiEffects of Constructivist Teaching, Prior Knowledge, Scientific Thinking in Biology, Understandings of
Nature of Science on 7th GradersGenetics Concept LearningP-521-974-973-1007

This quasi-experimental study was employed instruments of Biology Concept Inventory on Genetics (BCI-G), Test of Scientific Thinking in Biology (TSTB) and Questionnaire of Understandings of the Nature of Science (UNOS) both in constructivists teaching and conventional teaching, to examine effects of different teachings (744 students in constructivist teaching and 313 students in conventional teaching), prior knowledge, scientific thinking in biology, understandings of nature of science on 7th graders' genetics concept learning. T-test, ANCOVA, and regression method were used for data analysis. Results were: 1. regarding to effects on genetics concept learning, students in constructivist teaching outperformed than those in conventional teaching did, whereas no obviously differences of scientific thinking in biology or with less understandings of nature of science outperformed on genetic concept learning both in constructivist teaching and in conventional teaching, generally. Further, in the two teachings, three subgroups of TSTB or UNOS, and their interaction effects on genetic concept learning would reveal and discuss. 3. Among the variables, prior knowledge, and scientific thinking in biology were two important predictors. They explained 40.9% total variance of genetic concept learning.

Yuan-Cherng Lin Chia-Ju Liu

A Study on Learning Effects among Students with Different Learning Styles Using Chemistry Education Website

P-746-1584-1583-1613

The purpose of this study is to explore how the Chemistry Web of the Science Learning Website (SLW) influences the science learning of the 5th graders. There are 64 students in the experiment group receiving the instruction from the Chemistry Web and 56 students in the control group receiving the traditional teaching. The results found: (1) There is no significant differences were found between the experiment and control group but the science achievements of experiment group students with either the learning style of Diverger or Assimilator are better than those of control group students; (3) Most of students are delighted to take SLW as an assisting tool for learning. The suggestions from the students for the Chemistry Web are that it should base on the needs of students has more detail-interactive virtual experiments and more than one multi-assessment in one topic.

Miao-Hui Lin

The Effectiveness of a Professional Development Program for Teachers of Young Children Q-556-1045-1044-1078

This research is intended to develop cost-effective professional development programs for science teachers of young children. Forty nursery school and kindergarten teachers participated in the year-long 40-hour program. The first half of the program was focused on clarifying teacher's concepts of science and science education and introducing theories of constructive science teaching. The second half of the program was focused on introducing and demonstrating hands-on and investigation-based science activities. The results showed that the theoretical program during the first half of the study helped teachers develop a better understanding of science and science education. It enabled them to choose or design appropriate science activities, and improve their own teaching effectiveness. However, since this type of course was less active, participants showed less interest as this part of the course progressed. On the other hand, after seeing various hands-on activities demonstrated, teachers blindly incorporated these activities into their own teaching. This outcome showed that this kind of activity-oriented program might have some limited impact on improving teacher's competence teaching science. A cost-effective professional development model for science teachers can be beneficial to both rich and poor countries alike. It is a worthwhile endeavor to undertake further research in this field.

Shu-Fen LinHuey-Por ChangHsiao-Lin TuanExploring Mechanism of Science Intern Teachers Conflicts of Their Personal Practical Theory into
Teaching Change During Their Inership
Q-610-1163-1162-1195Participant Practical Theory into
Teaching Change During Their Inership

The purposes of this study were to investigate the conflicts of science intern teachers' personal practical theories (PPTs) in teaching practice, and to transform their conflicts into the power of teaching change by partnership mentoring model. Data collection included participant observation of two science intern teachers' teaching, team meeting during one-year internship and interviews with teachers, mentors, and students. All the data were transcribed verbatim and were analyzed by constant comparative method. It was found that two science intern teachers' PPTs were in conflict with mentors' as well as researcher's PPTs and students' image of a science teacher. Mentors' empowerment, intern teachers' insistence, and degree of conflict among mentors, intern teachers and students influenced intern teachers to decide whether to perform their PPTs in teaching practice or manage these conflicts. For intern teacher who had chances to perform one's PPTs, he/she would develop better understandings of PPTs on teaching effect, and then to reflect upon and modify their PPTs. Students' voice, argumentation on diverse perspectives, and intern teacher- centered mentoring were effective strategies to transform intern teachers' conflict into the power of teaching change. Keywords: personal practical theory, intern teacher, professional development

Britt Lindahl

A longitudinal study of students' attitudes towards science and choice of career *P*-672-1349-1348-1380

In the first part of the study I have followed 70 students from grade 5(12y) to grade 9(16y) to study the relationship between the students' attitudes, understanding and ability and how and why their attitudes change during school. My focus is pupils' reasons for choosing or not choosing science for high school. The second part of the study was done three years later just before these students left high school on their way to further studies or to working life. The results show that students have a positive attitude to science but often a more positive attitude to other subjects. As early as in grade 5 many students have an idea of their future career which later on is the same as their choice for high school and university. If science shall have a chance in their lives the students must have a positive experience of science from the beginning of elementary school through all years. Once they have lost their interest it is very difficult to get them back. The competition for their attention is intensive and the older they get the more difficult it will be to catch their interest and allegiance.

Lei Liu Cindy Hmelo-Silver Surabhi Marathe

RepTools: Representational Tools to Supporting Learning about Complex Systems P-137-810-809-844

Understanding complex systems is critical for becoming scientifically literate citizens. Examples of complex systems range from ecosystems to car engines. To learn about complex systems, students need experiences that engage them with complex systems phenomena. In this paper, we report on a classroom study that provides these kinds of experiences using a representational toolkit, RepTools. In particular, we focus on providing experiences with an aquarium ecosystem using RepTools as part of an inquiry curriculum that integrates hypermedia, a physical aquarium, and multiple computer simulations. The preliminary data analyses indicate the promising effects of the RepTools in supporting deep learning about complex systems and improving the teaching and learning of science. The conceptual representations embedded in the toolkit affected what students learned, as shown by the large gains particularly in the behavioral and functional aspects of the system. The visualization and manipulative opportunities provided by the NetLogo simulations afford students an opportunity to test and refine their hypotheses, which may lead to deeper understanding of complex systems.

Shiang-Yao Liu

Exploring Relations between Scientific Epistemological Beliefs and Decision Making on a Socioscientific Issue

P-565-1066-1065-1099

The main purpose of this study was to explore relationships between scientific epistemological views (SEVs) and decision making on a controversial issue, using two distinct instruments. The study also examined whether there is a difference on decision making processes of students with different academic disciplines. A total of 189 college students (60% science and 40% non-science majors), attending three public universities in southern Taiwan, completed both SEV and decision making questionnaires. Categorizations representing the types of information and arguments students used to reason their decisions on a local environmental issue and thinking disposition were generated from student responses to the open-ended questions. It was found that students with different majors used different arguments to support their decisions. Discriminate analysis was used to identify relations between SEV subscale scores and decision making patterns. Results revealed that students who recognized that science is tentative and changeable might consider more about technical features of the controversial issue, and more likely to discuss multiple sources of information or evaluate different statements to claim their positions. This study suggests that improving students' scientific epistemological beliefs may help them to make informed judgments about science and technology based issues.

Chia-Ju Liu **Houn-Lin Chiu**

How does scientific creativity affect conceptual change? P-592-1571-1570-1600

The objective of this research is to explore how scientific creativity affects conceptual change. Three hundred and eleven eighth grade students participated in this study. The results showed that scientific creativity significantly correlates with conceptual change on the concepts of particles and diffusion (r=0.712^0.747, P<0.001). The students with high scientific creativity were more successful at conceptual changes because they could construct emergent process mental models between the ontological categories than students with low scientific creativity (P<0.01).

Shiang-Yao Liu **Tung-Huang Yi Kuo-Hsiung Wang Oi-Tong Mak** Effects of a Biodiversity Course on College Students' Decisions about Conservation Issues 0-565-1069-1068-1102

This study aimed to examine the influence of a biodiversity course on students' reasons and decisions to some controversial issues related to bioogical conservation. The course was offered as a general education for non-biology undergraduates in a public university in Taiwan. We gathered some international and local conservation issues to develop a questionnaire. Students' views on the issues were assessed before and after the 16-week course. One hundred sixteen students (68% males and 32% females) attending the course participated in this investigation. Wilcoxon matched-pairs test showed that students' decisions became significantly more toward conservation side on four of the issues. In addition to the scientific concepts, the majority of students concerned more about the conflict between economic development and conserving biodiversity and the value of scientific research. Some students also presented political and ethical considerations about the controversial issues. Results concluded that students became more conservation minded on different types of issues and used more biological concepts to reason their decisions after taking the course. Further exploration of the factors that might influence the degree to which students committed to different reasons about the issues is desirable.

Xiufeng Liu William Boone

Preconference Workshop: Applications of Rasch Measurement in Science Education S-764-1644-1641-1671

Measurement is the foundation of quantitative research in science education. Over the last three decades, there's been a revolution in educational and psychological measurement, shaking the dominance of the classic test theory. The driving force is the development and application of the Item Response Theory (IRT). IRT is based on probabilistic modeling of item response patterns. The Rasch family of models, unique in its conceptual assumptions and parameter properties, has differentiated themselves from the rest of IRT models and become a distinct measurement approach. Test developers and researchers in fields such as learning progression, equity, teacher education, and cross- cultural studies routinely apply Rasch models. In science education, more science educators are beginning to recognize limitations of the classic test theory, and are turning to Rasch models. This workshop intends to demystify Rasch models to the science education community, so more researchers appreciate their power and become confident in applying them in solving significant science education research problems. This workshop will introduce basic terms and ideas of Rasch models, major computer software tools for Rasch analysis, including hands-on practice using a free Rasch analysis software (BIGSTEPS), demonstration of sample applications using real data, and a collection of resources.

Christine Lotter Robert Feller

Impact of a High School Teacher Professional Development Model on Teachers' Views of Science and Science Teaching P-652-1314-1313-1345

This paper investigated 23 secondary teachers views of science and science teaching before and after their participation in an intensive two-week inquiry professional development program. The professional development model, which included inquiry pedagogy instruction, science content instruction, daily videotape reflection, and practice teaching with high school students, was based on a successful program implemented with middle school teachers. The purpose of this study was to evaluate the strengths and weaknesses of the model with high school teachers and determine whether the workshop resulted in changes in the teachers views of science and inquiry teaching. Changes in the teachers beliefs were gathered from semi-structured interviews, audiotapes of discussions during the workshop, and daily written reflections. After the workshop, the teachers expressed more informed views of the subjective and social/cultural aspects of the nature of science and expressed a deeper understanding of how to implement inquiry teaching. Of the four workshop components, the teachers expressed the greatest change in their views of teaching and learning after implementing their inquiry lessons with the high school students. Gains in the teachers content knowledge were observed through increases in the teachers mean scores on content tests. Implications for future professional development are explored.

Cathleen LovingRui KangAbdurrahman ArslanyilmazChristine ShimekBruce HerbertSusan Pedersen

Novice ACP Science Teachers' Levels of Success With Inquiry: A Multi-case Study of the Effects of Professional Development P-340-1546-1545-1576

The purpose of this research was to determine factors that contribute to success or barriers that prevent ACP secondary science intern and induction year teachers from gaining knowledge and engaging in classroom inquiry as a result of an innovative professional development experience. The PLC-MAP project uses the Chinn and Malhotra (2002) framework as a basis for the types of inquiry we do and the elements of reasoning we emphasize. Project leaders recently added an element to that framework from a series of technical papers of the Inquiry Synthesis Project (2004) allowing for different levels of saturation of inquiry teaching for novices. A multi-case study design was used for this research. We adopted a two-tail design where cases from both extremes (good and poor gains) were deliberately chosen. Six science teachers were selected from a total of 40+ mathematics and science teachers. These six, on average, demonstrated either the highest gain in knowledge and/or engagement in inquiry-based teaching or the lowest gain among all the novice science teachers through the year of participation in the PLC-MAP program. Certain patterns emerged across all six cases, even when the other variables are acknowledged. The principal external factors were school climate its culture, its mandates, its degree of teacher autonomy. The internal factors were teacher beliefs about learning through inquiry, about their own need for additional knowledge, and about managing inquiry--all tied to degrees of self-efficacy.

Sheraton New Orleans Hotel • New Orleans, LA

April Luehmann

Blogging as Support for an Urban Science Teacher's Professional Identity Development P-359-871-870-905

Teachers need ongoing support as they face new challenges and develop a more sophisticated sense of professional identity as reform-minded practitioners. The difficulties of reform-based science teaching are further exacerbated in the challenging conditions of typical urban settings. The potential of online web logging (blogging) to support teachers in their professional learning has yet to be explored. In this case study I explored the unique affordances a web log (blog) offered to Ms. Frizzle, one reform-minded urban middle school science teacher. Findings suggest that Ms. Frizzle used her blog to simultaneously support and be supported by a professional community that spanned traditional geographical, ideological and institutional boundaries. More specifically she used her blog to foster a unique professional community, to try on and develop a variety of interrelated professional sub-identities, to position herself centrally within a larger professional discourse, and to exercise considerable agency over her professional development. To realize these benefits, Ms. Frizzle invested significant time and energy to her blogging practices in multiple ways. Consideration of what she put into blogging alongside what she got out of it illuminates implications for teacher educators or others who hope to support teacher learning through blogging.

April Luehmann

Urban Students and School Science: Out-of-School Inquiry as Access O-359-874-873-908

Students, especially students not represented in the culture of power such as many students in urban settings, need opportunities to find their voices in science and then have these unique voices heard by those in the culture of power, most notably, teachers. Out-of-school inquiry programs hold the potential to address these identity needs of urban students. This study explores how collaboration between schools and a university program offered 292 urban students unique access to school science. Eight secondary urban science teachers engaged in a year-long collaboration with university facilitators which culminated in a half day, on-campus laboratory visit for their students. Analyses of student and teacher interviews and surveys revealed 1) characteristics unique to this experience that emerged as important contributors to the realized benefits 2) perceived benefits including unique ways students were engaged and recognized in science learning and practice; and 3) possible connections between these design features and realized benefits. Building on the valuable perspectives of insiders (urban science teachers and students), this study demonstrated that carefully designed out-of-school inquiry programs, in collaboration with teachers' work in science classrooms, have the potential to both broaden students' experiences as well as bridge them to this academic culture of power.

Gail LueraSusan EverettCharlotte OttoDeveloping a Measure to Assess the Pedagogical Content Knowledge of Pre-Service Elementary TeachersConcerning ModelsQ-676-1355-1354-1386

While much research has been conducted on students' conceptions of models, limited assessments have been created to assess teachers' pedagogical content knowledge of models and modeling in science. We began the process of developing a measure to assess the PCK of our students in a capstone course focusing on the unifying theme of models. We used a three circle Venn diagram to provide a visualization of the different types of knowledge combined in PCK that we wanted to assess: subject matter of models in science, teaching strategies for K-8 science and student learning. We developed 10 open-ended questions that focused on the intersections of these three types knowledge. The questionnaire was piloted with 53 pre-service elementary teachers in a pre-and post-test design. The responses were analyzed and showed student PCK increased. The responses were used to revise several of the questions to form a revised questionnaire of 11 open-ended questions.

Cynthia Lundeen

Parental Involvement in a Home-School Science Initiative as a Predictor of Positive Attitudes About Science Education

Sibel Kaya

P-481-1641-1638-1668

Barriers to parent in science involvement that exist in schools are largely due to lack of knowledge schools and families possess on how to effectuate involvement. A year-long professional development initiative provided the intervention for study to identify predictors of parents' positive attitudes about science involvement. 108 teachers from four schools participated in a sustained Family Science Initiative promoting parent involvement strategies. Parent surveys (n=158), observations, and interviews (n=34) comprised the data set. Data analyses were approached through multiple methods to extend the validity of the results. Results revealed that comprehensible home-school science activities significantly increase parental involvement and efficacy in science education. Implications for sustained science partnerships inclusive of basic process skills and content promote parent interest and involvement.

Cynthia Lundeen Diana Rice

Time on Task: Increasing Science Teaching Time in the Elementary Classroom Through a Sustained Professional Development Initiative Q-481-1642-1639-1669

Limited science teaching time is the pervasive finding when looking at elementary classrooms due in large part to teacher choice. A sustained university-school Science Teaching Intervention Professional Development Program was designed for elementary teachers aimed to improve teachers'science teaching time and interest along with their science teaching efficacy beliefs through implementing cooperative, hands-on, and meaningful science teaching techniques. A study was implemented to measure the results of the program in terms of time spent teaching science and types of science strategies used. Data sources included observations, anecdotal records, individual and group interviews, and pre- and post- Science Teaching Efficacy Belief survey STEBI-B, (n=25). Results showed statistical significance in the improvement of science teaching self-efficacy but not in student outcome expectancy beliefs. Teachers' demonstrated heightened confidence and comfort in designing and delivering science professional development program appears to reverse some negative roadblocks in quantity of science instruction time within the elementary classrooms.

Mats Lundström

Students' beliefs in pseudo-science P-393-691-690-725

This paper reports from a study about knowledge and beliefs in science and pseudoscience in health related issues. A web based questionnaire about knowledge in human biology and beliefs in pseudoscience has been answered by Swedish high-school students. The aims of the study are to examine high school students' beliefs in pseudo-scientific phenomena related to the body and our health and if there is any relationship between those beliefs and knowledge of human biology, studied science courses or education programme. The survey measures relationship to science and scientists, beliefs in pseudoscience and knowledge in human biology. Results from the study show a correlation between science education and knowledge in human biology. However, no clear correlation between science education or human biology knowledge and scepticism against pseudo-science was found. Neither was there any relationship between sex and pseudo-scientific beliefs. The increase of different types of information related to pseudo-science in media like New Age health related advertising and articles are the base for the study and importance of developing life-long skills to handle conflicting information are discussed. The paper is arguing for the importance of investigating and analysing students' beliefs in science contra pseudo-science as a means of achieving scientific literacy.

Sharon Lynch Carol O'Donnell Elizabeth Hatchuel Vasuki Rethinam William Watson Vasuki Rethinam Vasuki Rethinam

A Model Predicting Student Outcomes in Middle School Science Classrooms Implementing a Highly Rated Science Curriculum Unit: P-394-826-825-860

In order to restructure science education research, careful documentation of the Comparison conditionoften dismissed as merely 'traditional'--must be thoughtfully built into study design. In the present study, the intervention was a middle school science curriculum unit on motion and forces, highly rated according to Project 2061's Curriculum Analysis. We compare Characteristics of Implementation (COI)--teaching strategies and student perceptions of curriculum components roughly aligned with the Project 2061 criteria--in a random sample of Treatment and Comparison classrooms implementing motion and forces units. A conceptual model describes how TeacherCOI and StudentCOI may differ in Treatment and Comparison classrooms and its effects on student learning outcomes. Descriptive results showed that Comparison classrooms used combinations of curriculum materials and instructional strategies that were not 'traditional'. TeacherCOI and StudentCOI were found to predict student outcomes in Treatment classrooms, but not Comparison classrooms. The combination of the highly- rated curriculum unit plus teaching strategies affected student outcomes positively, but similar strategies were not as effective in Comparison classrooms where teachers selected their own curriculum materials. This experimental study advances a model of COI that may be viewed as a sophisticated measure of Fidelity of Implementation, embedded in a large quasi- experiment.

Valery Lynn Barbara Crawford

The influence of a museum internship on prospective science teachers subject matter knowledge and pedagogical strategies for teaching nature of science and science inquiry *P*-366-637-636-673

This study examined the influence of a science museum internship on prospective science teachers' views and practices of teaching science as inquiry. Two prospective science teachers participated in a year long internship, MPS Internships in Public Science Education- MPS-IPSE: Internships for Bringing Today's Science to Tomorrow's Scientists, sponsored by the National Science Foundation (NSF). The key research questions included: 1) to what extent did these prospective teachers articulate understandings of inquiry, nature of science, and materials science concepts, including nanotechnology; and, 2) to what extent did museum experiences influence views of teaching science as inquiry? We were interested in the interactions the interns had in this setting with the public, the interns' expectations, the kinds of support they received, and interns' views of science and science teaching. One of the greatest challenges they encountered was how to facilitate young learners in understanding difficult abstract materials science concepts, including nanotechnology. Creating museum shows challenged interns to make abstract and/or sophisticated scientific concepts accessible and interesting to an audience ranging in age from small children to adults. We will discuss the affordances and constraints of a science museum setting in developing prospective teacher knowledge of inquiry and the nature of science.

Maritza Macdonald Heather Sloan Ellenor Miele Wayne Powell Rosamond Kinzler

Myles Gordon

Improving Urban Earth Science Education: The TRUST Project Q-120-854-853-888

TRUST is an NSF-funded collaborative model for Earth science teacher preparation. This model brings together an urban science-rich institution and two colleges to address a science instruction problem: a shortage of certified Earth science teachers in a high-stakes context that requires science exams for graduation. As a result, many students do not meet graduation goals because many schools cannot find Earth teachers. The TRUST model is driven by a set of problem-solving questions: how do we prepare Earth science educators and support them beyond preparation? What content must Earth science teachers master? What types of learning experiences best facilitate content mastery? What is required for certification? What do we bring individually? What is the benefit of a partnership? What institutional conditions will it require? Our research and practice contribution is a promising and replicable model of formal- informal teacher education partnership. In addition, we propose that urban settings often have institutions that make effective, flexible, and science-rich education partners. Presenters discuss and present evidence of the program components, evaluation, focus on certification policies, importance of pedagogical content knowledge, flexibility required of problem-driven solutions to educational problems and the need for replication, research, and theory development of partnership models.

Leo MacDonald Ann Sherman

Young Students' Perspectives on Chemistry Summer Camps Q-46-132-131-168

Children of ages six to twelve years participated in eleven chemistry summer camps over two summers. A total of 253 children were surveyed at the beginning and at the end of the summer camp about their opinions, attitudes, and ideas about science concepts taught at the camps. In addition, a total of 114 students were interviewed in focus groups to help describe the programs and to analyze the effects of the summer camps on students' interest in the learning of science. For the youngest children, individual interviews were held using alternative strategies such as photo prompts and drawing opportunities to enable them to more fully share their experiences. A range of narrative data were collected where children described not only what they had experienced at camp, but also expanded on what they knew about science through stories or drawings. Students talked with enthusiasm about experiments and demonstrations they had participated in. Children as young as six and seven years of age drew detailed pictures of molecules and wove science understandings throughout personal narrations that included a strong use of scientific terminology.

Maritza MadonaldAdriana AquinoWilliam SchillerRachel ConollyArts and Science Course in a MuseumQ-370-1391-1390-1422

Arts and Science in a Museum Course for Teachers Effective arts and science collaborations for teacher preparation continue to be elusive. Finding innovative models is an interesting puzzle for scientists and educators focused on improving education in general, and science education in particular. This session presents action research perspectives of an arts and science team who developed, implemented, studied and revised a graduate level course on Resources for Teaching Science. Over 160 teachers have participated in eight semesters over a five- year period. Participants attend a Masters program for science teachers at a local college and the course is required for graduation. The partnership and courses evolved in direct response to the call for reinvention of teacher preparation proposed by the NCTAF in, What Matters Most: Teaching for America's Future (1996). More recently, instructors link the importance of the topic to a design principal of Teachers for a New Era, which requires that faculty in the disciplines of the arts and sciences must be fully engaged in the education. The presenters will focus on responses to questions and their course revisions after evaluating: What teachers learned from scientists, from experienced teachers, and teacher educators? In addition, how was learning at the museum different from learning on campus or in schools? And evidence from student work and observed museum field trips.

Sheraton New Orleans Hotel • New Orleans, LA

Jenine Maeyer Vicente Talanquer

How novice prospective teachers approach lesson planning and assessment P-646-1555-1554-1584

The secondary school science teacher preparation program at our university recently implemented a pilot project to enrich the direct teaching experiences of prospective science teachers prior to student teaching. In this new model a science teaching course on curriculum design and assessment is paired with a college level introductory science course for non-majors. Prospective teachers enrolled in the science teaching course work side by side with teacher educators, science instructors, and their peers in the planning, implementation, and assessment of meaningful learning experiences for the non-science majors during an entire semester. Our study was designed to investigate the planning, instructional, and assessment practices of prospective science teachers involved in this project. Our results indicate that study participants hold fairly common, albeit flawed, beliefs and practices about lesson planning and assessment. They tend to view lesson planning as the process of selecting content and activities that engage and motivate students, without sufficient reflection about how to effectively foster meaningful learning and accurately assess student understanding. Too often prospective teachers assess a lesson's success based primarily on inward focused views of their personal teaching performance rather than truly measuring the impact that their lesson had on student learning and understanding.

Nida'a Makki

Preservice Teachers' Explorations in STS: Problems and Promises P-733-1542-1541-1572

Reform documents (NSES, Project 2061) affirm the importance of teaching social issues in science for all students as a mean for responsible citizenship. However, many science educators are concerned that this policy commitment has not been translated into classroom practice. There is a wide recognition that science education programs need to address the perceived practice- policy gap (Bybee, 1991), however, little seems to be achieved in convincing teachers of the merits of such an approach. To help us understand this problem better, this study seeks to explore how preservice teachers come to understand, value and appropriate STS in their methods classes.

Kathy Malone

Categorization of Physics Problems by Modeling and Non-Modeling High School Physics Students and its Correlation with Problem-Solving Performance P-14-870-869-904

The Modeling Instruction pedagogy for the teaching of physics has been proven to be quite effective at increasing the conceptual understanding and problem- solving abilities of students as measured by the Force Concept Inventory and the Mechanics Baseline Test. Little research has been conducted concerning the knowledge structures that modeling students develop that could account for these increases. In this study the knowledge structures developed by both modeling and non-modeling students were determined using a card sort task designed to be isomorphic for surface features. The knowledge structure developed by the students was quantified via expert, surface feature and questions asked scores. The student's knowledge structures were then correlated to the scores they obtained on two measures: FCI and a problem solving task (PS Task). At the end of a year long course the modeling students had a more expert-like knowledge structure while non-modeling students produced structures that were more surface feature oriented. In addition, the expert score correlated highly with performance on both the FCI and PS Task scores demonstrating that a higher expert score predicted a higher value on each of these measures while a higher surface feature score predicted a lower score on both of these measures

Adam Maltese

Robert Tai

The Role of High School Laboratories in Student Performance in Introductory College Science P-212-432-431-468

Laboratory experiences are fundamental to science instruction. However, some pedagogical approaches are more effective than others in preparing students for success in college science. This study seeks to provide some insight into the connection between the instructional methodologies students experienced in high school laboratories and their performance in introductory college science. The study analyses surveys from over 5,000 college chemistry and physics students from 47 different four-year colleges and universities. The results indicate that a strong focus on lab procedure appears to be associated with lower college performance. Conversely, focusing on post-lab understanding, and connecting laboratory experiences with students' beliefs appear to be associated with higher college performance.

Jacqueline Manno

Carla Zembal-Saul

Change in the Teaching of Elementary School Science: The Role of the Pre-Service Intern in Influencing Mentor Teachers' Beliefs and Pedagogical Practices within a Professional Development School Context Q-618-1323-1322-1354

The purpose of this research study was to investigate the nature of change in PDS mentor teachers' beliefs and pedagogical practices toward science education in the elementary school as conveyed through their stories of practice. This study examined the changes made by elementary teachers working within the context of a professional development school district. Findings suggest that the role of the university pre-service intern was integral to the development and change in both the beliefs and practices of elementary teachers toward reform- based science education. The pre-service intern served as the enabler for this change as well as a significant other with which to discuss and practice reform-oriented methods in the elementary science classroom. As Professional Development Schools continue to be a focus of implementation in colleges of education across the country, it is important to be aware of this connection in order to effectively develop this relationship in programs. Additionally, gaining a thorough understanding of this pre-service/in-service teacher partnership has the potential to be vital to the growth and success of elementary teachers' professional development in science.

Constantinos Manoli Bruce Johnson

The Relationship Between Children's Environmental Perceptions and Ecological Actions P-659-1596-1595-1625

The purpose of the study was to investigate the relationship between students' environmental perceptions and ecological actions before and after attending Earthkeepers, an earth education program. Participants were 600 4th, 5th and 6th grade students from 14 schools in Arizona and Pennsylvania. A paired sample t-test analysis revealed that students who had more pro- environmental perceptions after the program also undertook more ecological actions, for example using less energy and fewer materials, than their counterparts. An analysis of variance revealed no significant difference in the pre- program environmental perceptions of those who later did more actions and those who did fewer.

Gili Marbach-Ad	Patricia Seifert	Scott Barnett	Niv Ad
Phillip Sokolove	Edward Lefrak		

Cardiac surgery observation dome to enhance awareness of disease risk factors and career choices in high school students: Using Personal Meaningful Mapping (PMM) Q-73-286-285-322

Since 1985 the Inova Heart and Vascular Institute has offered a one-day educational visit at the hospital. High school students come to the hospital with their teacher and watch a live open-heart surgery through an observation dome located above the cardiovascular operating room (CVOR). During the procedure a designated cardiac surgery nurse describes the operative procedure, highlights a variety of health profession careers, and discusses cardiovascular risk factors and life-style modification strategies. The visit is designed not only to increase content knowledge, but also to improve students' awareness of cardiac disease risks and risk reduction strategies. In this study we used the Personal Meaning Mapping (PMM) method, a flexible assessment methodology for collecting data in informal settings. PMM asks visitors to record and/or illustrate their thoughts, feelings and word associations in relation to the topic of the visit as a pre-visit task. Following the visit the students are asked to review their previous PMM and are welcomed to add, delete, modify, or change their maps. The comparison between the pre-visit drawings shows that students have gained better awareness to heart disease risk factors and to opportunities for career choices in heart surgery.

Nanette Marcum-Dietrich

Using constructivist theories to educate the 'outsider' Q-102-170-169-206

Some students are 'outsiders' in today's science classroom. What makes an outsider and how can teachers break down barriers to reach these students? This case- study details one teacher's journey as she attempts to understand and connect with an outsider in her science classroom. It is a poignant account of self-reflection; an account that incorporates current educational theory in an attempt to make the border crossing into the science classroom easier for one disconnected student.

Karen Marshall

Learning in an Informal Context: A Summer Science Academy Experience P-692-1392-1391-1423

This study reports the findings of a qualitative study within the model of out-of-school time (OST). Studies within this model suggest that what is learned by students outside the classroom, such as in summer camps, weekend and after-school enrichment programs, can supplement classroom learning. The goal of this study is to present a view of OST science experiences from the perspectives of the Young Scientists' Academy (YSA) student participants and their parents. Specifically, this paper seeks to: (1) describe the OST science experiences of the YSA participants, (2) describe parental perspectives of their child's OST science experience, and (3) provide a qualitative assessment of the impact of the YSA participant OST experience on science performance. The source of data for this research study was the transcriptions of the semi-structured interviews with the five OST participants and their parents, and two focus groups of parents and participants. Preliminary findings indicate that OST experiences may have positive impacts on in-school science performance. Findings also indicate that those who participated for a minimum of 70 OST hours showed an increased interest in everyday, as well as in-school science.

Sonya Martin Christina Jacobs Tracey Otieno

Evaluating changes in science teaching practice using a Lesson Plan Analysis Instrument P-106-1200-1199-1232

In evaluating the success of teacher development programs, measures of teaching practice that are valid, reliable, and scalable are needed. We have developed, validated and piloted the Lesson Plan Analysis Instrument (LPAI) for quantitative evaluation of teacher-submitted multi-day lesson plans. This method is complementary to traditional tools such as teacher surveys and direct observational protocols. Instrument design was guided by constructivist and socio-cultural learning theory and established reform-oriented teaching standards, as well as the central principles of the instructional program context in which it was developed. Our goal was to capture the extent to which our teacher development program is meeting its goals with of increasing teacher content and pedagogical knowledge and impacting teaching practice. The purpose of this paper is to present the development and validation of the LPAI, and to demonstrate its use in a pilot study examining teacher change as a result of program instruction. The pilot study was designed to track and describe changes in teaching practice and pedagogical knowledge at the individual and cohort levels over time, and thereby provide evidence of program effectiveness.

Sonya MartinEdward LehnerSusan KirchChristopher EmdinRethinking professional development partnerships: Coteaching as a means for investigating, changing and
renewing praxisS-106-1191-1190-1223

Coteaching can be a powerful means for science educators to transform the nature of the classroom experience for the teacher and the students. In this symposium, we describe how coteaching is providing insights and direction for improving teaching and learning in four different K-16 science classroom settings. Symposium participants are introduced to four different studies, each investigating the effectiveness of coteaching as a model for professional

development. To facilitate this discussion among symposium participants, presenters will introduce the theoretical and practical benefits of employing coteaching as a methodological approach to classroom research and a pedagogical approach for improving praxis among in-service science teachers in science teacher education. Presenters provide participants with strategies and insight helpful for implementing coteaching in different school settings. Along

with sharing implementation procedures, this session also shares approaches for evaluating these arrangements using a variety of methodological and theoretical frameworks.

Patricia Martinez

Brenda Bannan-Ritland

John Baek

Implementing a Technology System Combining Inquiry-based Science and Reading Comprehension Strategies to Help Second Language Learners Improve their Understanding of Scientific Text in a Bilingual Environment P-235-388-387-424

This study investigates the parallelism among strategies students develop during scientific inquiry and their transfer to reading of scientific text. 59 students at the fourth grade level were randomly assigned to read one of the three versions of a text written in Spanish, and answer 9 comprehension questions. After that, 13 students were assigned to the treatment group. The treatment consisted in 4 lessons using the technology system Go-Inquire . In addition, these 13 students participated in a two-session lesson using reciprocal teaching (Palincsar & Brown, 1984) and bilingual strategies (Jiménez, García & Pearson, 1996). All participating students then took the same comprehension test and were asked to write a summary. A preliminary analysis of the data shows students consistently obtained a higher score when reading the culturally sensitive version of the text, after controlling for pretest differences. The analysis of the gain from pre to posttest indicates that 92% of the students who participated in the treatment improved their scores in the reading comprehension test. This study will inform the impact of the use of cognitive strategies in inquiry-based science that parallel those used in reading on students' ability to comprehend scientific text.

Lisa Martin-Hansen

Inquiry and the Pre-service Science Teacher *Q-593-1142-1141-1174*

The purpose of the study was to examine one program's effectiveness of developing pre-service science teachers' understandings of inquiry and their abilities to implement inquiry lessons in the classroom. Over four semesters, pre- service teachers practiced inquiry teaching and learning in class, practica and student-teaching. Quantitatively, the Repeated Measure Multivariate Analysis of Variance (MANOVA) was utilized (n=7)with a Tukey post-hoc comparison of the Open Inquiry Assessment Rubric scores (OIAR, reliability .8 or better),(Author, 2001) on course documents. Qualitative interviews were conducted, transcribed, and then coded using the constant-comparative method (Glesne, 1998) with two researchers. Data analysis showed a positive statistical significance in the pre-service teachers' understandings of inquiry. They reported reasons to implement inquiry in the classroom and also identified roadblocks.

Michael Matthews

Joseph Priestley and the Enlightenment: Teaching Chemistry and the Cultural Contribution of Science P-82-144-143-180

Joseph Priestley was an enormously gifted 18th century person. He was a polymath who made valuable and original contributions across a wide range of subjects history of science, political theory, theology, biblical criticism, theory of language, philosophy of education, rhetoric as well as the better known fields of electricity and chemistry in science. 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. These cultural goals can be advanced by incorporating study of the life, times and achievements of Joseph Priestley into science programmes. Examples of teaching materials will be given whereby students can learn that: 1.Philosophical thought, or worldviews, have an impact on scientific thinking. 2. Scientific discoveries are difficult and have social and technical components. 3. There are epistemological, psychological and social elements involved in changing major scientific theories. 4. The Scientific Revolution gave birth to the European Enlightenment. 5. How an important scientist and Enlightenment figure understood scientific habits of mind and how he applied them to pressing questions of religion, politics, and philosophy that still resonate in the 21st century.

Mary Mawn Kathleen Davis

Teachers as Learners and Scientists: Using Inquiry in an Online Chemistry Course for Elementary and Middle School Science Teachers Q-145-380-379-416

Teachers' knowledge, experiences, and beliefs greatly impact what takes place in the science classroom, with reports of positive correlations between teacher preparedness and student achievement. Much thought needs to be given to how teachers learn to teach; what teachers know; how their knowledge is acquired; how it changes over time; and what processes bring about long-lasting change in the classroom. Strong links between personal learning and the classroom context are also important in changing teacher beliefs and practice. Offered as part of an online graduate program at a large university in the northeastern United States, the online chemistry course described here provided elementary and middle school science teachers with coursework designed to meet their needs. Through inquiry-based activities, teachers worked as scientists as they hypothesized, investigated, analyzed, and discussed fundamental chemical concepts. These experiences contributed to teacher learning of science content and strengthened their science process and critical thinking skills. By the end of the semester, teachers showed gains in their confidence for teaching these concepts as indicated by pre- and post-course surveys. This study investigates how the inquiry-based nature of the course activities fostered teachers' learning of science content, and modeled the teaching of science through inquiry.

Kirsten Mawyer Daniel Edelson

Beliefs, Decisions and Adaptations: A Test Case Study of a Teacher s Participation with Investigations P-441-1143-1142-1175

This study takes the decisions that teachers make when adapting curriculum as sites where educational beliefs become apparent. This focus allows us to investigate the educational beliefs held by teachers and how they draw on their educational beliefs to make decisions about adapting curriculum materials. After identifying the educational beliefs that a teacher calls upon as she is adapting, we compare across the teacher's decisions to look for thematic patterns in the interactions with the curriculum finding in this case a significant tendency to draw on beliefs about students. This study has the secondary purpose of testing a think aloud interview protocol for eliciting a teacher's educational beliefs. In particular, it explores this tool's utility for providing the information required to make inferences about a teacher's educational beliefs as she makes decisions about how to adapt the curriculum.

Serena McCalla David Treagust

Teaching for understanding: A comparison of grade- 9/10 student performance using diagnostic and standardized assessments in photosynthesis/respiration and genetics Q-237-449-448-485

Success in the New York State Regents examinations can be obtained by memorization instead of conceptual understanding. To address this concern, over one year of instruction, Grade-9/10 students were taught photosynthesis/respiration and genetics. Several instructional strategies were used to encourage a deeper level of student understanding. Students responses to two- tier diagnostic examinations and standardized questions from past Regents examinations were compared to assess their competence in these two domains. Subsequently, students were interviewed to ascertain which type of assessment they perceived best measured their understanding of these two topics. The vast majority of students stated that diagnostic testing best assessed the knowledge gained during the year and this was confirmed by comparing the results on the two assessments.

Ellen McCallie

Are They Really Talking With Each Other?: In-depth analyses of dialogue events on socio-scientific issues for adults at ISIs P-450-990-989-1023

The general purpose of dialogue events on socio-scientific issues is to engage people who have a wide variety of expertise--science, social-science, and life experience--in open and challenging discussions about current, science-based issues of societal interest in a socially equitable forum for dialogue and argumentation. While practitioners have worked to develop the practice of these events, dialogue events on socio-scientific issues have yet to be examined theoretically or systematically. This paper presents empirical results of in-depth analyses of six dialogue events from two Informal Science Institutions (ISIs). Specifically, this paper addresses the research questions: What happens at dialogue events on socio-scientific issues at ISIs? and What factors affect the development of these events? The study uses discourse analysis to examine how language mediates and shapes social interaction among people participating in the events. Thus, this study addresses gaps in the academic literature: it describes a relatively new form of event occurring in museums, how they work, and how they can be studied. The results of this study are being implemented by ISIs to promote more open, equitable, and challenging dialogue among invited speakers and participants.

Cherie McCollough

The Creation of a Pedagogy of Promise: Examples of Educational Excellence in High-Stakes Science Classrooms P-463-928-927-961

The current reform movement in education has two forces that appear contradictory in nature. The first is an emphasis on rigor and accountability that is assessed through high-stakes testing. The second is the recommendation to have student-centered approaches to teaching and learning. This mixed-methods research study investigated four exemplary urban high school science teachers in high-stakes (TAKS) tested science classrooms. Classroom observations, teacher and student interviews, pre-/post-content tests and the Constructivist Learning Environment Survey (CLES) provided the main data sources. Results revealed that all participating teachers incorporated the elements of How People Learn (HPL)classrooms with significantly positive increases in student content knowledge. In addition, teachers exhibited similar strategies for managing tensions associated with HPL elements and high-stakes tests. For example, they used familiar analogies as relevant examples, incorporating prior knowledge. They used students prior experiences and made them an integral part of the classroom content. Teachers established a climate of caring where students felt supported and motivated to learn while demonstrating mutual respect and negotiation strategies. Recommendations are provided including the increased development of student-centered curricula, using multiple test-criteria versus one single standardized test, and increased teacher training to assist in the creation of a climate of caring.

William McComas

Donna Farland

Enhancing the Draw-A-Scientist Test: The Rubric and its Reliability P-719-1529-1528-1559

For many years researchers have been interested in determining individuals' perceptions of scientists. One instrument which has been used in a variety of studies is the DAST or DRAW-A-SCIENTIST TEST in which subjects are asked to draw a scientist at work. For appropriately ten years, a frequent assessment of this the DAST has been the Draw-A-Scientist Checklist (DAST-C). The DAST-C is merely a checklist for scoring students' illustrations and only focused on the negative seven stereotypical elements only focused on the APPEARANCE of the scientist in the drawings. After reviewing many hundreds on drawings, this researcher noted trends in the pictures students' would draw about scientists, and in all cases they included three specific components, APPEARANCE (what the scientist looks like), as noted in the DAST-C, but also a specific LOCATION (where the scientist is working) and ACTIVITY (what science is being done). Therefore, the DAST-C is not suitable for scoring these two other features commonly present in children's drawings of scientists and a new instrument was needed. The paper discusses how the DAST Rubric was specifically designed to ensure consistency among scorers and its inter-rater reliability among teachers with varying levels of experience.

Tom McConnell

The impact of collaborative reflection on preservice elementary teachers understanding of technology integration in the science classroom. P-156-787-786-821

The purpose of this study was to examine the influence of collaborative reflection on the technology pedagogical content knowledge of pre-service elementary science teachers. Fourteen participants engaged in reflection about their use of technology in their practice as undergraduate teaching assistants in a biology course for elementary teachers over a sixteen week semester. One group of informants engaged in reflection individually. Two other groups each participated in collaborative reflection. Qualitative interviews, group discussion meetings, electronic reflective journal entries, surveys and classroom observations provided data about the participants' understanding of technology integration. Qualitative data were analyzed to identify conceptually-ordered and time-ordered patterns of responses. Individual cases were constructed to compare similarities and differences between key informants from each group. Results showed individual reflection group members retained initial concepts of technology as a teacher tool, while members of the collaborative groups developed a new view that included more variety in the ways technology could help science students to learn. Implications of the study include the use of collaborative reflection about technology integration as a strategy for accelerating the development of technology pedagogical content knowledge in pre-service teachers.

NARST Annual International Conference 2007

Scott McDonald Gregory Kelly

Building the Science Storyline Using the Mole Concept P-249-1188-1187-1220

This study examines how two chemistry teachers, one prospective and one practicing, develop a science storyline in their respective classroom to support students' understanding of the mole concept. Each teacher taught five lessons where they developed an extended analog for the mole based on ratios of cookie ingredients. Through analysis of videotape of the lessons the researchers examined how the teachers used discourse to create a multithreaded science storyline. These storylines were created through specific discourse practices, including: use of intertexuality and metadiscourse, and managing the conceptual shift from macro-level phenomenon to micro-level explanations for those phenomenon. Classroom discourse practices, used in the context of analogical reasoning, worked as pedagogical elements of inquiry. The teacher / student dialogue was critical for developing deep understanding of this key chemistry concept.

James McDonald

Lynn Dominguez

Facilitating Content Knowledge Through Indepth Examination of Environmental Issues P-266-821-820-855

Preservice teachers and environmental education students' knowledge, awareness, and involvement were measured using pre/post test and reflections following a semester long science issues investigation project. The purpose of this presentation is to communicate the findings of a science learning action team project completed in a required elementary science methods course (EDU 345) and a required introductory environmental education course (RPL 216) that allowed students to gain knowledge and develop skills that will lead to more science content knowledge of an issue that they chose to research. Females comprised 76% and males 24% of the students taking the pretest and post-test. The majority of students were juniors or seniors (91%) and 9% were freshmen or sophomores. Growing up, 62% of the students lived in a rural area or a small town or village. Over 97% of the students indicated they had enjoyed playing outside when growing up and 92% had enjoyed swimming in a lake or river. Camping was an enjoyable activity for 82% and 64% enjoyed watching wildlife.

Maisy McGaughey Philip Bell

Fifth grade students images of science, identity and cultural border crossings P-536-1480-1479-1510

This paper examines the intersection of identity, images of science and cultural border crossing in order to generate greater understanding of the barriers to science, technology, engineering and mathematics achievement for those students who are currently underrepresented in these disciplines. The primary research questions in this study of fifth graders are: How do students understandings of their identity intersect with their understanding of STEM disciplines? How does the intersection of identity and perceptions of science impact students pathway choices related to STEM education? This investigation primarily uses elicitation interviews to collect data that builds on previous models of cultural border crossings and school science (Phelan, Davidson & Cao, 1991; Phelan et al. 1994; Costa 1995). Through our interviews we have identified practices of border crossings by learners of school science that provide opportunities for teaching and learning in diverse student populations. We report on these categories of findings and discuss educational implications.

J. Randy McGinnis Angelo Collins

Publication in the Journal of Research in Science Teaching P-769-1656-1653-1683

Participants in this session will become familiar with the submission, review, and the communication process of the Journal of Research in Science Teaching. This session welcomes all those who are interested in submitting and publishing in JRST or anyone who would like to become a reviewer for the journal. JRST Editors, Associate Editors, Editorial Board Members, reviewers and JRST Editorial Office Staff will be present to share information, experiences, and answer questions.

Katherine McNeill

The Role of the Teacher in Supporting Students in Writing Scientific Explanations P-718-1523-1522-1553

The role of the teacher is essential for students' successful engagement in scientific inquiry practices. I examined how middle school science teachers supported their students in one particular inquiry practice, the construction of scientific explanations. This study focuses on an eight-week chemistry curriculum that explicitly supports students in constructing scientific explanations about phenomena in which they justify their claims using evidence and reasoning. Participants included six teachers and 568 students. I analyzed videotape from each teacher and two teacher questionnaires to develop case studies that characterized the support each teacher provided their students for scientific explanation. Patterns from these case studies suggest that the teachers defined scientific explanations in a variety of ways for their students. These different definitions of scientific explanation influenced the other instructional practices that the teachers engaged in to support their students. There were also differences in the classroom discourse across the teachers in terms of whether the conversation was solely teacher driven or whether the students also took initiative and ownership in the classroom discussion. Teacher differences in instruction around scientific explanation may reflect their beliefs about what counts as scientific explanation and science instruction.

Yvonne Meichtry

Beginnings: the EE RIG at NARST P-772-1663-1660-1690

This invited symposium hosted by the new environmental education strand (14) will consider the unique contexts that environmental education may provide for science education and its associated research. The discussion will be prompted by brief presentations from invited panelists (above) that will examine the historical, present and future condition of environmental education activities at NARST. Participants will engage in facilitated discussions aimed at building capacity within the new strand while working towards a shared vision for future research dissemination activities hosted by the environmental education strand.

Joi Merritt Yael Shwartz Joseph Krajcik

Middle school students development of the particle model of matter P-316-1342-1341-1373

One of the most difficult concepts for students to understand is that of the particle nature of matter. In the United States, traditional curriculum materials present the particle theory as a fact without providing opportunities for students to develop and apply this principle. The Investigating and Questioning our World through Science and Technology (IQWST) project takes the approach of building students' ideas through constructing and revising models. This paper focuses on the chemistry unit of the IQWST curriculum entitled How can I smell things from a distance? This unit emphasizes modeling as an important scientific practice for middle school students to learn and to help students understand the particle nature of matter. In this unit, students create models to explain and predict different phenomena. This paper discusses how 6th grade students' understanding of the particle nature of matter changed as they participated in a contextualized and model based unit in chemistry. It explores how different phenomena and the practice of constructing models influenced students' views of matter. Our results provide evidence that most sixth grade students can move to a particle view of matter.

Shari Metcalf Carolyn Staudt Robert Tinker

TEEMSS2: Technology Enhanced Elementary and Middle School Science P-662-1292-1291-1323

Technology Enhanced Elementary and Middele School Science (TEEMSS2), has the goal of bringing the power of information and communication technology to science education in grades 3 8, by creating and disseminating valuable, proven, and easily implemented technology-based science learning materials and associated teacher professional development. The project has selected age-appropriate, standards-based content for which technology offers real advantages. The learning strategy is based on student investigations of real phenomena using sensors and of virtual environments based on computer models. The new materials take advantage of computers, sensors, handhelds, and electronic networking to more effectively teach students and give them deeper insights into the process of science inquiry. This paper reports on the results of classroom testing of TEEMSS2, which showed both quantitative and qualitative evidence of student learning when teachers implemented the materials in their classrooms.

Catherine MilneJan PlassBruce HomerTrace JordanSlava KalyugaOf minds and molecules:Developing cognitively appropriate simulations for high school chemistryP-273-1619-1618-1648

This project has three main goals for students with little prior experience of chemistry: design, develop and evaluate animations and simulations; test the effectiveness of simulations in functioning high school chemistry classrooms; and integrate simulations into chemistry curricula. The initial simulations were developed for the gas laws and now the project team is working with chemistry teachers to develop simulations in areas of chemistry that they have identified as important to their chemistry curriculum such as kinetic theory and phase changes. The team has conducted usability and cognitive load trials and experiments in high schools to test the initialtheories in 'real world' contexts. The research has broader implications for the design of representations used in chemistry education especially for beginning learners.

James MinogueGail JonesTom OppewalBethany BroadwellHaptic Feedback and the Structure of Observed Learning OutcomesP-97-291-290-327P-97-291-290-327

The application of Biggs' and Collis' (1982) Structure of Observed Learning Outcomes (SOLO) taxonomy in the evaluation of student learning about cell membrane transport is described in this study. The SOLO taxonomy is composed of five levels of sophistication: Prestructural, Unistructural, Multistructural, Relational, and Extended Abstract and it is designed to provide educators and researchers with a systematic way to analyze the structure of children's understandings. Pretest-posttest comparisons of student outcome data (n = 80) were made across two groups of randomly assigned students: one that received visual and haptic feedback and one that relied solely on visual feedback as they completed a computer-based instructional program. The results of the independent t-tests indicated that the group mean difference scores were significantly different statistically (p = .023). Practically speaking, this study provides some early evidence suggesting that the haptic augmentation of computer-based science simulations may lead to a deeper level of processing. The strengths and weaknesses of this diagnostic approach and its potential contribution to the teaching and learning of science are discussed.

Sabine MoggeHelmut VogtBernd Wollring

Qualitative analysis of interviews with primary level students working with M(odeling)-open biological and mathematical problems

P-363-629-628-665

Qualitative analysis of interviews with primary level students working with M(odeling)-open biological and mathematical problems The conducted interview study deals with primary level students' individual characterizations of the so-called M (odeling)-open format and their modeling processes aroused when working with M(odeling)-open problems, the above subject to the individual typological occurrence of attitude towards school and Sachunterrichts-lessons (TOASL: Zest-for-Learning-Type (ZLT), Bored-Frustrated-Type (BFT) and Aim-oriented-Achievement-Type (AAT)). The 24 primary level students interviewed had worked on two input-based M- open problems from the biological and mathematical domain, first individually, then in collaboration with a student of the same TOASL. We found that the students' statements could be grouped to categories. They revealed that the BFT is the one of the three types that showed the greatest potential to be stimulated by the M-open format, which supports domain-specific and methodical expertise. The ZLT also demonstrated a general positive attitude towards the M- open format. However he presumably did not acquire its potential to the extend the BFT did and was not consistently focused on the M-open format's main aspects while modeling. Finally, the AAT widely declined the M-open format.

Laura J. Moin Christian Schunn

Some elements to design effective math and science teacher recruitment programs P-545-1010-1009-1043

The US education suffers a severe shortage of science teachers which impact on the quality of education. Current recruitment efforts are costly and have enjoyed limited success. This paper studies some elements that may contribute to increase their efficiency. We conducted a survey of perceptions of teaching and career objectives among SEM undergraduates. We found empirical support for the teaching experience hypothesis (having a teaching experience increases the likelihood of pursuing teaching careers) but also found that there is room for recruitment growth. Low salary appears to more negatively affect subjects who haven't experienced teaching. Support in the form of classroom management seems key for recruitment success. Finally, altruistic reasons are the strongest motivators both for experienced and non-experienced subjects.

Rachel MollSamson NashonDavid AndersonThe Impact of Participating in Physics OlympicsCompetitions on Student's Attitudes towards PhysicsP-468-1197-1196-1229

Low enrolment and motivation are key issues in physics education and recently the affective dimension of learning is being studied for evidence of its influence on student attitudes towards physics. Physics Olympics competitions are a novel context for stimulating intense emotional experiences. In this study one team of students and their teacher were interviewed and observed during the event to characterize their emotions and to make connections between their experiences and their learning and attitudes/motivation towards physics. A theoretical framework based on social constructivism and perceptual-motivational theories of emotion and an interpretive, case study methodology were used. Students' attitudes that physics is fun, diverse and relevant and perceptions about who does physics were themes that were revealed in post event interviews. A third theme emerged which showed the effect of classroom based perceptions on attitudes towards physics. Analysis of these themes was conducted to show the interrelatedness of emotion and attitudes towards physics. Results point to the value of informal and novel contexts in physics for their potential to create strong emotions and change student attitudes towards physics.

Rebecca Monhardt Jon Orris

The TRRBOE Project: A Place-Based Professional Development Program for Elementary and Middle School Teachers on the Colorado Plateau P-540-994-993-1027

This paper describes teacher perceptions of a place-based summer professional development experience which is part of the NSF sponsored Teacher Retention and Renewal through Bioregional Outdoor Education (TRRBOE) project. Teacher participants are from rural and/or resource poor schools on the Colorado Plateau with substantial numbers of American Indian students. During the summer institutes, teachers engaged in intensive field- based learning activities where they learned strategies for using the natural environment to teach science. For many participants, this was their first experience in this type of outdoor setting. The underlying premise of the summer experience was that teachers themselves must feel comfortable in an outdoor setting if they are going to implement outdoor science activities with their own students. Findings suggest the importance of the social aspect of residential professional development experiences; the necessity of careful cultural considerations in selecting professional development activities; the critical importance of a knowledgeable project staff; and the empowerment that can result when teachers are challenged to move outside their comfort zones.

Felicia MooreMagnia GeorgeBryan BrownBrian WilliamsEileen ParsonsBradford LewisPromoting New Directions in Science EducationS-413-732-731-766

The purpose of this symposium is to present new or under- utilized approaches for addressing issues we feel are pertinent to research in science education around issues of diversity, equity, teacher education, and student learning. Drawing upon multiple theoretical frameworks, positions, and research approaches, this symposium takes seriously the notion of what works in transforming, challenging, and educating teachers and students in science education. Therefore, we invite teacher educators who are interested in improving their teaching practices around issues of diversity and equity; classroom teachers who encounter diversity daily in their teaching of science; curriculum developers who are interested in understanding what it takes to design science curriculum that considers issues of diversity; and all who are simply interested, struggling, and successful at incorporating discourses around diversity and equity in teaching and learning, in classrooms and out of school spaces, in curriculum, and in research and policy.

Judith Morrison Amy Roth McDuffie

Connecting Mathematics and Science: Using Inquiry Investigations to Learn About Data Collection, Analysis, and Display P-119-1093-1092-1126

The purpose of this study was to explore the effect of providing preservice teachers the opportunity to collect real data in a science methods inquiry investigation and using that data, design data displays in their mathematics methods course. The research questions focused on how preservice teachers' understandings of data displays, research design, and the specific content addressed improved when they used these displays to attempt to communicate the data they had collected themselves in their inquiry investigations. The 46 preservice teachers were given questionnaires at the beginning and end of the courses, twelve were interviewed both pre and post, all written work pertaining to data displays and the inquiry investigations was collected, methods class sessions were audio and videotaped, and the final data display and science investigation projects were photocopied. The findings show that by creating and scrutinizing their data displays, the preservice teachers were able to recognize the limitations of their inquiry investigation design. Through working with data in the context of inquiry projects of their own design, the preservice teachers realized meaningful connections and commonalities that exist in mathematics and science while strengthening their knowledge and skills in both disciplines.

Hedy Moscovici Irene Osisioma

Designing the best pre-service urban elementary science methods course dilemmas and considerations Q-353-704-703-738

This paper addresses the dilemmas encountered by a secondary science faculty designing a course for pre-service elementary teachers. Taking into consideration past experience of teaching education and science courses in general and with pre-service elementary teachers in particular, recommendations from national and state documents (e.g., Science Framework for California Public Schools, 2003) and state requirements regarding teacher credentialing (e.g., benchmarks for the credential program), the introspective reflection uncovers the complexity involved in making decisions regarding course goals, course assignments, and assessment strategies, course materials, all in an effort to better prepare the preservice elementary teachers to be able to meet the new demands in urban science classrooms.

Frackson MumbaShawn HennonSebastian SzyjkaNatalie PerelesWilliam HunterEffect of Explicit Intruction on High School Physics Students Knowledge and Skills for Contructing andInterpreting GraphsP-406-1218-1217-1250

The purpose of this study was to assess the effect that explicit instruction had for high school physics students' knowledge and skills for constructing and interpreting three graphs common in school curricula and media: pie charts, bar and line graphs. A quasi-experimental design was used in this study. Four physics classes were randomly assigned to experimental and control groups. A sample comprised 77 high school physics students. Quantitative and qualitative data were collected through pre and post- tests and students' artifacts and interviews respectively. Quantitative data was analyzed using paired t-tests and One way ANOVA while qualitative data were analyzed via coding and identifying recurring themes. After the intervention, both the t-tests and One way ANOVA showed a significant difference between experimental and control groups; thus suggesting that participants in experimental group maintained their incorrect ideas on graphing. However, a majority of participants in both groups said they (1) liked, in descending order, pie chart, bar and line graphs (2) preferred reading existing graphs to making and reading their own. Some recommendations for instruction and future research on graphing have been stated.

Colette MurphyJim BeggsKaren CarlisleRevisioning Science Teacher Education for the 21st Century: Coteaching and Cogenerative DialogueP-512-1040-1039-1073

This work provides an overview of a five-year systematic investigation into the use of coteaching and cogenerative dialogue to address challenges facing teachers and student teachers of science in 21st century classrooms. It draws on data collected from approximately 70 schools and complements other coteaching research, which mostly comprises ethnographic studies. Teachers of science face different challenges from those in the last century, including less subjugated students, fear of litigation, more inclusive classes, increased regulation and accountability and newer, more discursive teaching approaches in which they must make science relevant to the lives of the students. Furthermore elementary teachers who may not have a background in science are required to teach relatively complex scientific concepts to young children. In this study, undergraduate Bachelor of Education (BEd) science in an extra school placement that comprised their science methods course. Findings showed that the students' practical teaching grades improved and that there was an observed redistribution of power relationships between pupils, student teachers, classroom teachers and teacher educators. The impact of coteaching and cogenerative dialogue on pre-service teachers, cooperating teachers and children is considered in terms of sociocultural theory.

Kusalin Musikul Sandra Abell

Professional Development for Primary Science Teaching in Thailand: Knowledge, Orientations, and Practices of Professional Developers and Professional Development Participants P-619-1186-1185-1218

This study examined an entire professional development (PD) project as a case to understand the dynamic nature of science PD for primary teachers in Thailand. We utilized an effective professional development design model as a framework in examining an entire PD project--design, delivery, and outcomes--in a holistic manner. We also used a pedagogical content knowledge model as our research inquiry framework in examining the professional developers' and teacher participants' knowledge, orientations, and practice to professional development and primary science teaching. Data included interviews with four professional developers, observations of an entire physical science PD institute, interviews with four teacher participants, and follow-up observations in those teachers' classrooms. We examined the dynamic nature of PD and its consequences in terms of how science professional developers' orientations, knowledge and beliefs about PD, teachers, science curriculum, instructional strategies, and assessment play a role in PD design and delivery. We also investigated the relations of these beliefs and PD practices to participants' orientations, knowledge, and beliefs about science teaching, students, science curriculum, instructional strategies, and assessment orientations is consequences.

Michelle MyersPenny HammrichSonia RodriguesSisters in Science Equity Reform ProjectP-250-413-412-449

One of the many efforts to remedy the gender inequity is the Sisters in Science Equity Reform Project (SISERP). Funded by the National Science Foundation for over twelve years, the project focuses on the diversity inherent in learning through various tools by which scientific and mathematical principles can be explored, analyzed, and communicated. SISERP houses six innovative science programs designed to foster gender equity and inclusion in science, technology, engineering, and mathematics (STEM) education: Sisters in Science (SIS), All Sisters in Science (ASIS), Sisters in Sports Science (SISS), Sisters in Science in the Community (SISCOM), Information Sisters in Science Career Opportunities Matter (iSIS. com), and Sisters in Science Dissemination and Outreach Program (SISDO). The primary goal of the SISERP programs is to provide urban school aged girls with access to meaningful STEM instruction in an environment unencumbered by the restrictions of stereotypical practices regarding gender.

Ratna Narayan

Writing Science in an Inquiry-Based Undergraduate Biology Laboratory for Non-Science Majors P-219-360-359-396

This qualitative, interpretive study examines analyzes the linguistic characteristics of student writing samples generated during inquiry-based activities and endeavors to relate them to the student's understanding of the content taught. The study was situated in a in an inquiry-based laboratory for non-science majors. Participants included eight students, the two teaching assistants and a laboratory teaching intern. Primary data included students writing samples, participants were interviewed thrice. The first level of data analysis was based on Halliday's (1985) assertion that grammatical structure was intimately linked to the meaning of language. Several linguistic features were recorded. A second level of analysis involved coding the data by thematics, i.e. the meanings generated by student's propositions (Keys 1999). Inter- rater reliability was 97%. Results lead one to believe that the writers presented their written investigations with little reflection ascribed to the meaning of the data. Interview data revealed that participants had difficulty following and expressing in writing, the chain of reasoning between evidence and conclusions. This was considered to be indicative either of a lack of conceptual understanding of the material or due to their inexperience with the demands of the writing task assigned. Implications extend to educators as well as course designers among others.

mutindi ndunda Irene Osisioma

Urban High Schools: Factors That Enhance And Those That Impede The Learning Of Science. P-162-384-383-420

This proposal discusses preliminary results for a qualitative study that investigated the factors that influence math and science achievement of minority students in two urban high schools in Southern California. The students in the two schools were drawn from similar social environment. The study used ethnographic data collection and analysis strategies. The main data collection strategy was classroom observation focusing on classroom environment, student-teacher and student-student interactions, modes of instructions (small groups, whole class or hands-on activities). We observed the level of cognitive demand of the students' tasks/activities. The results show significant differences in teaching and learning within the two schools. In one school, the school environment was conducive to learning. In the other school, the environment was not. In one school, learning was student centered and content was of high cognitive demand. In the other school, the learning was teacher centered and the cognitive demand of the content was low. School contexts with high administrative support had classroom environments that had high teacher support with fairness and clarity of tasks. Schools with less administrative support had classrooms with less teacher support and clarity of tasks with content of low cognitive demand.

Ross Nehm Leah Reilly

Measuring knowledge of natural selection: A methodological comparison of C.I.N.S., an open-response instrument, and oral interview *P*-605-1162-1161-1194

This study compares the results from three different measures of natural selection knowledge: (1) the Conceptual Inventory of Natural Selection (CINS; Anderson et al. 2002); (2) the Essay Instrument (EI) of Bishop and Anderson (1990) and Nehm and Reilly (in press); and (3) an oral interview developed from these instruments. Our results indicate that Key Concept diversity, which is a measure of the number of different components of natural selection that students harbor, was significantly correlated between the CINS and EI (n = 100, Pearson = 0.56, p < 0.001). Additionally, Misconception diversity was significantly (but weakly) correlated between the instruments (n = 100, Pearson = 0.36, p < 0.001). A finer- grained analysis of individual question responses, however, reveals substantial differences in knowledge and misconceptions. These differences appear to be the product of the open-ended nature of the EI. Oral interview transcripts were most similar to the EI results. We explore how these different measures differentially inform science educators about the knowledge that their students and teachers harbor, evaluate the strengths and limitations of each metric, and discuss appropriateness of these instruments for measuring evolutionary knowledge in science teachers.

James Neufell Richard Duschl

The Efficacy of Learning Physics First: A Pilot Study Research Report Q-143-901-900-934

The purpose of this study was to assemble an empirical base that describes and examines the impact of the physics first curriculum. Specifically, this study explored students' experiences with the physics first sequence and perceptions of NOS. The following research questions guided this inquiry: * What do students who have been through the physics first sequence say about their experience? * Do they apply physics to their study of the other sciences? * Do their experiences in physics facilitate their learning in chemistry? Biology? If so, how? * In what ways do students who have followed the physics first sequence demonstrate an understanding of nature of science? * How is this understanding different from student views reported in the literature? * Results of this study demonstrate that there are perceived benefits for students in following the physics first curriculum sequence. This research suggests that learning science content as well as aspects of NOS is facilitated by implementation of the physics first curriculum sequence. Studying the development of students NOS attitudes and conceptual development while completing the physics first sequence has the potential to contribute to researchers' knowledge of science learning, science teaching as well as effective science/math formative assessment models.

Birgit Neuhaus Wen-Hua Chang

Taiwanese and German students attitude towards science and the nature of science What can we learn from a comparative perspective? P-458-1052-1051-1085

The students' attitude towards nature of science is well explored. Nevertheless, there are only few studies comparing different countries. In Europe, students are often neither interested in nor informed about science research, whereas Asian countries seem to be more enthusiastic about new technologies. The presented study examines these differences. Participants were 917 students from Taiwan and Germany whose attitude was measured with a questionnaire comprising six scales. In order to avoid misunderstandings ascribed to the translation items were translated from English into German and Chinese and vice versa. Data were analyzed in terms of differences between the two countries, gender, and age by multivariate ANOVA. All scales showed acceptable values of internal consistency. In both countries male students were significantly more enthusiastic about science research. However, students in Taiwan were more enthusiastic than their German colleagues (F = 182.0, N = 615, p d 0.001). The enthusiasm decreased from grade 7 to grade 12 in Germany whilst it remained stable in Taiwan (F = 3.6, N = 615; p d 0.029). To know the general tendency of German students in comparison to their colleagues abroad, may help to get a realistic view on how to improve teaching in Germany.

William Newman Jr

Elementary Students and Pre-Service Teachers Perceptions of Rock Layers Q-351-1270-1269-1301

Because students are rarely exposed to Earth science after middle school, misconceptions about Earth science phenomena are common. To better understand the extent and details of Earth science misconceptions, I researched the understanding of rock layers by elementary pre-service teachers and elementary students. Each of the participants examined photographs of the Grand Canyon that clearly illustrated extensive rock layers. They then described prominent features, provided explanations for the features, and answered questions during semi- structured interviews focused on the rock layers evident in the photographs. The participants provided a variety of explanations for the layering, few of which were scientifically valid. The knowledge of the college students, even those that had taken an Earth science university course, scarcely differed from those of the elementary students.

Mansoor Niaz Ramón Fernández

Understanding Quantum Numbers in General Chemistry Textbooks P-277-644-643-680

Objectives of this study are: 1. Elaboration of a framework based on aspects: a) Origin of the quantum hypothesis; b) Alternative interpretations of quantum mechanics; c) Differentiation between an orbital and electron density; d) Differentiation and comparison between classical and quantum mechanics; e) Introduction of quantum numbers based on electron density. 2. Formulation of five criteria based on these aspects (a, b, c, d, e). 3. Evaluation of 55 general chemistry textbooks. Results show that on Criterion 1: None of the textbooks described satisfactorily that Planck's role in the origin of quantum hypothesis was more at the level of empirical adjustment, whereas Einstein provided the physical significance. Criterion 2: Few textbooks included alternative interpretations of quantum mechanics and thus ignored that most theories are underdetermined by experimental evidence. Criterion 3: None of the textbooks described satisfactorily that orbitals are mathematical constructs and the shapes of the orbitals (s, p, d, f) are not derived from quantum mechanics but instead from electron density measurements. Criterion 4: None of the textbooks presented a framework to facilitate transition in student understanding from classical to quantum mechanics. Criterion 5: Few textbooks facilitated introduction of quantum numbers based on experimental determination of electron density.

Dianna Nichols Dan Churach Darrell Fisher

Industry-sponsored, content-rich professional development: Influences on attitudes towards applied science P-55-108-107-144

The paper reports on a novel project aimed at having a positive impact on the 'people shortage' within the minerals and energy sector in Australia. The project includes a series government-industry-funded teacher professional development events aimed at highlighting the value of applied science in contributing to the nation's wealth as well as showcasing a variety of career opportunities for students. The literature review supports the notion that teachers have a high degree of influence on both the high school course selection and the career choices their students make. Using the collaborative resources of academic, research and industrial partners, teachers involved in the program have multiple opportunities for gaining hands-on laboratory experiences in the chemistry and physics of mineral processing. The professional development offerings also afford a variety of tours to research facilities and organises site visits to mines and processing plants of industry partners. Quantitative and qualitative evaluation of the effectiveness of this pilot program at impacting on teacher attitudes towards the industry is reported. Finally, the extent of integration of professional development activities within existing curriculum is assessed.

Wendy Nielsen Samson Nashon David Anderson

Awareness and control as metacognitive dimensions of group learning behavior P-286-608-607-644

Metacognitive awareness and control are two key dimensions of individual learning behavior. Awareness can be considered an entry-level behavior for engaging with the learning situation, and when learners function in groups to work on classroom activities or projects, individual behaviors contribute to the group effort. The learning context for this paper involves high school biology students visiting the Vancouver Aquarium for curriculum-based experiences that are linked to follow-up activities back in the classroom. The study engaged students in novel problems with the express intention of activating metacognitive behavior, and uses an activity theory framework to observe and analyze group interactions in the context of these activities. The goal for this paper is to describe the manifestation of the metacognitive dimensions of awareness and control in the context of group problem-solving activity.

RenaFaye Norby

Hands-on Science in a Standards Rich Environment Q-40-641-640-677

Students in this study are non-traditional students, almost exclusively female with many African-American students, typically more than 8 years out of high school, with little or no higher education, and are seeking certification for teaching grades K-5. Many of these learners only know didactic methods of science teaching and tend to either dislike science or have little confidence in their ability to teach science. While enrolled in the science methods class, these students complete surveys of attitude towards science survey. The methods class is conducted to emphasize constructivist based learning and standards emphasized in the NSES: understanding of unifying concepts, the nature of science as a human endeavor, inquiry based science, and the interaction of science and technology. Hands on activities and guided discovery learning are emphasized. Science content knowledge related to the state performance standards is also emphasized in this class. This poster session will report attitude changes and level of science content knowledge, as well as anecdotal remarks made by the students about their interest in science and their confidence in being able to teach science after class completion. Students also expressed increased confidence in being able to teach science at the K-5 level.
Jeffrey Nordine David Fortus Joseph Krajcik

Supporting Middle School Students' Development of an Accurate and Applicable Energy Concept P-403-1311-1310-1342

Because energy is an abstract scientific concept, it is applicable to a great variety of complex phenomena. Yet, its abstract nature also makes if a very difficult concept to learn, particularly for young children. Traditional approaches to energy instruction focus on calculation and do not seem to help students use energy concepts to simplify and interpret everyday phenomena. Our development team has produced a new curriculum that focuses students on energy transformations in everyday phenomena and does not include energy calculations. This study is intended to investigate the efficacy of such an approach compared to more traditional approaches. Using a quasi- experimental design, we compared 8th and 9th grade students who have participated in our new energy unit to the 10th and 11th grade students in the same school who had the same teachers before they enacted the unit. Results indicate that energy unit participants are more capable of making sense out of everyday phenomena using energy concepts, are less likely to harbor alternative energy conceptions, and are well positioned to succeed on standards-based distal assessments.

Jeffrey Nordine

The Influence of Teacher Knowledge and Beliefs in Developing Middle School Students Content Knowledge and Scientific Explanations During a Project-Based Chemistry Curriculum Q-403-1334-1333-1365

Just as students' prior knowledge and beliefs affect the lens through which they interpret school science activities, teachers' prior knowledge and beliefs affect the way they enact school science activities. As curriculum designers work to develop innovative materials that are targeted to national standards and benchmarks, it is crucial that they understand how teacher characteristics such as subject matter confidence and predisposition toward particular instructional practices are likely to affect student outcomes. In this study, I used data collected during an enactment of a project-base middle school chemistry curriculum to investigate how teacher knowledge and beliefs were related to student gains on identical pre/post tests that measured their content knowledge and ability to formulate scientific explanations. Teachers' confidence with chemistry was a strong negative predictor of student gains on both content and explanation measures. Furthermore, chemistry confidence had a more negative effect for teachers who had a disposition toward more traditional teaching methods. These results suggest that curriculum developers may need to provide educative curricular supports for teachers who feel especially confident with their subject matter, as these teachers may be more likely to short-circuit the expected benefits of learning science through inquiry.

Joseph Novak Alberto Canas

Preconference Workshop: The Use of Concept Maps for Improving Research, Teaching, and Learning S-765-1646-1643-1673

This workshop will offer guidance in the use of CmapTools, a software program developed at IHMC, for use in research, teaching, curriculum planning, collaborative work, and knowledge archiving. The software, developed largely through grants from NASA, Navy, NSA, and other Federal agencies, is available to educators and their students at no cost and includes many special features not found in other concept mapping software. The workshop will begin with guided practice in use of CmapTools software and then proceed to illustrations of various applications for the software in research, teaching, and knowledge engineering, and finally end with discussion of workshop participants' needs, applications, and questions.

Ingrid NovodvorskyDebra TomanekVicente TalanquerComparing Experienced & Prospective Science TeachersReasoning about Assessments

P-171-385-384-421

The purpose of this study was to characterize secondary level experienced and prospective secondary science teachers' assessment reasoning by identifying cognitive and contextual factors that influenced their selection of formative assessment tasks. Data analysis involved coding of written responses from ninety-two teachers to three task probes. The types of cognitive factors that influenced teachers' reasoning were remarkably similar, but teachers associated different meanings with the factors. Contextual factors related to the abilities of students and characteristics of the curriculum were also influential in reasoning. The variety of meanings associated with the cognitive factors coupled with the influence of contextual factors suggests that efforts to improve classroom assessment practices in science will meet challenges that involve teachers' reasoning and beliefs.

Gwen Nugent Gina Kunz

Inquiry and Field-Based Learning and Instruction for Pre-Service Teachers P-58-382-381-418

This study extended the authors' earlier research on the effects of a field-based geoscience course for pre-service teachers through the addition of a week of inquiry pedagogy instruction and the opportunity for students to implement mini-lessons with middle school students. This NSF-funded project focused on assessing course impact and identifying strategies for effective teaching and learning of geoscience. Outcome measures for the pre-service teachers included content knowledge, understanding and development of inquiry skills, and attitudes and motivation towards science. Analysis of covariance comparisons were done between field course students (n = 13) and education students in the traditional, classroom- based course (n = 8). Results indicated that students in the field course scored significantly higher than students in the traditional course on measures of inquiry, confidence for teaching science, and attitude toward science. There was no significant difference between the two instructional groups on content knowledge, indicating that students in the two courses gained an equivalent amount of geoscience knowledge. Results confirm the effectiveness of integrating science content and pedagogy to provide improved opportunities for pre-service teachers to develop inquiry skills and attitudes needed to meet current classroom demands.

Robert Ochsendorf Curtis Pyke

Assessment Practices in Science Curriculum Materials Research: Do Students Learn from the Pretest? P-435-1432-1431-1463

This paper reports on a study of the effect of pretesting on middle-school students' learning in different motion and forces curriculum conditions. Since current policy in science education calls for educators and students to view assessment situations as learning opportunities, pretests have been increasingly implicated as a confounding cause of learning in recent curriculum evaluations. Therefore, this research employs a four-group design to test the pretest effect hypothesis. Pretest classrooms were randomly selected from five matched pairs of schools (each pair implementing one of two curriculum conditions) (n=295 students) while students in the remaining classrooms did not receive pretests (n=1725 students). Findings reveal a correlation between pretest scores and posttest scores as expected, but no differential pretest effects on posttest performance across curriculum conditions. Overall, whether or not students took the pretest did not influence posttest scores. Implications for contemporary curriculum evaluation research are discussed.

Carol O'DonnellSharon LynchJoelle LasticaSuzame MerchlinskyConsidering the Role of Fidelity of Implementation (FOI) in Science Education Research: Analyzing the
Relationship between FOI and Student Outcomes in a Quasi-experiment
S-566-1067-1066-1100Suzame Merchlinsky

Rigorous intervention research in science education requires that a study not only describe whether the intervention is effective, it should also capture fidelity of implementation (FOI), or degree to which the intervention is implemented in comparison with the original program design (Mihalic, 2002). The purpose of this symposium is to explore FOI in the context of a large quasi-experiment that affected 67,000 students over six years and examined the effectiveness of middle school science curriculum units highly rated according to the AAAS Project 2061 Curriculum Analysis (AAAS, 2003). After grounding the problem of the study, this symposium consists of four presentations addressing FOI from three perspectives: (1) conceptual--proposing a model for studying the relationship between FOI and student outcomes in a quasi-experiment; (2) methodological--reporting FOI data collected through multiple methods and analyzed using descriptive, bivariate, and regression analysis; and, (3) practical--considering the role school district program evaluators and science supervisors play in collaborative research collecting FOI data in classrooms and addressing teachers' concerns about it. It is our contention that valid studies of reform-based interventions must pay careful attention to FOI and that such consideration of FOI is necessary for the restructuring of science education research.

Feral Ogan-Bekiroglu

Pre-Service Physics Teachers' Attitudes Towards Assessments and Factors Affecting Their Attitudes P-113-1046-1045-1079

In this study, it was aimed to identfy pre-service physics teachers' attitudes towards assessment. In addition, it was attemped to examine the relationships between some factors and their attitudes. Self-efficacy about assessing students, internal difficulties i.e., assessment skills and subject matter knowledge, and external difficulties were taken under scope to examine their effects on the pre-service teachers' attitudes. Data were collected from different sources to develop a detailed composite description of the pre-service teachers' attitudes. Based on the results drawn from the different sources, the pre-service physics teachers' general attitude towards assessment was categorized as close to constructivist. No relationship was found between the pre-service teachers' attitudes and their self- efficacy about assessment. Likewise, no relationship emerged between their attitudes and assessment skills. On the other hand, the pre-service physics teachers' subject matter knowledge and some external difficulties would affect their predispositions for action. Conclusions carry implications for teacher education.

Meshach Ogunniyi

Effectiveness of a Discursive/Argumentation-based History, Philosophy and Sociology of Science Program in enhancing Teachers Conceptions of the Nature of Science P-155-307-306-343

In the pursuit of scientific literacy for all citizens, a plethora of programs has developed by researchers in many countries to enhance teachers' and students' understanding of the Nature of Science (NOS). However, most of these programs have been based mainly on the works of well known historians and philosophers of science at the exclusion of the works of sociologists (including psychologists) of science. Consequently, teachers trained through such programs have tended to emphasize the hypotheticodeductive NOS at the expense of the socio-cultural dimensions of science (McComas, 2000; Author, 2006). This study exposed a group of science teachers to a discursive/argumentation-based History, Philosophy and Sociology of Science Program (HPSSP) for three hours a week for six months. The teachers filled a pre-post NOS questionnaire, attended interviews and wrote two reflective essays based on their experiences in the program. The data obtained were analyzed in terms of four non-hierarchical epistemic-metaphysical categories. The findings show that based on their experiences in the program the teachers were more sceptical about the notion that science reveals the truth about reality. They were less inclined to construe science as an immutable body of knowledge and became more aware of the psychosocial context in which scientific practices take place.

Stacy Olitsky

The Role of Disciplinary Faculty in Facilitating the Development of Teacher Knowledge for Implementing Inquiry-Based Science Instruction P-185-333-332-369

This qualitative study focuses on a program in which disciplinary faculty worked as partners in efforts to reform secondary school science instruction. The paper examines the interactions between faculty and teachers during five professional development sessions on an inquiry-based curriculum. Results suggest that faculty can help teachers prepare for inquiry-based instruction by contributing their expertise on issues such as reducing misconceptions, interpreting data, and explaining concepts more accurately. Faculty also promoted reform by using inquiry methods in their contact with the teachers, rather than lecturing. Structural features of the sessions that contributed to success included a focus on experiments from the curriculum, the professors' prior participation in professional development for inquiry, and ongoing contact between teachers and faculty.

Stacy Olitsky

How Can College Science Instruction Change to Model Student-Centered Approaches? Lessons from a Partnership Connecting Science Faculty with Schools Q-185-332-331-368

This study focuses on a project intended to facilitate positive change in secondary school science teaching through providing opportunities for university-level faculty to work with teachers. Results show that the project influenced not only teachers' practices within these schools, but also the instruction of the participating faculty within their own college-level courses. Many of the participating faculty found that through focusing on issues of pedagogy in professional development sessions, visiting schools, and designing courses with teachers, a by-product was that their pedagogical philosophies had changed and that their own teaching became more inquiry-based and student-centered. However, many of the faculty also experienced structural obstacles that constrained them from implementing all of the types of changes that they found desirable.

Alandeom OliveiraTroy SadlerSuslak DanielThe Linguistic Construction of Expert Identity in Professor-Student Discussions of ScienceP-244-406-405-442

This study examines how participation in a verbal exchange during an inquiry-based classroom activity allows three college students and their science instructor to use linguistic signs (choices of words, grammatical structures, discursive structures, prosody and poetic discourse) to construct authority/ expertise locally. Our work explores linguistic and interactional processes of identification (the dynamic construction and transaction of expert identity) and examines how discursive strategies adopted by the professor at different moments of the verbal exchange influence the students' subsequent discursive practices and perceptions of authority. We adopt a dialogic, socio-constructivist perspective on identity, viewing personal identities as being partially constructed via interactional positioning. Our findings reveal that the attainment of expertise involves two different types of language-mediated processes: the transmission of a professional vision or intension and the emergence of a perception of agency among students. The former is centered on referential/denotative meanings of speech (elicitation of standard account and operation definition) while the latter requires effective use of pragmatic/performative functions of speech (non-evaluative and more than minimal recipient practices). Consideration is given to the need for science instructors to be able to utilize pragmatic functions of language strategically to encourage students to position themselves within the identity of science authority/experts.

Leslie Oliver Jennifer Iverson Phyllis Balcerzak

Learning Progression on DNA and Protein Synthesis: A Tool for Analysis and Effecting Change in Science Curricula

P-636-1284-1283-1315

Incumbent on our educational system is the development of curricula for K-12 designed to promote a synthesis of concepts and knowledge in the field of biotechnology. Learning progressions (LPs) help students develop clear understandings of central principles in science. This paper highlights key aspects of the development of a collaboratively created and research-based LP focused upon DNA and protein synthesis. The content of our LP corresponds with the relevant learning goals of AAAS Benchmarks (1993) and NRC National Science Education Standards (1996). Our LP situates the learning of three topics within grade bands that precede those in the standards so that, 1) K-3 children learn about major organs and organ systems and unicellular organisms, and 2) middle school students learn about cell structures and functions, and protein functions at the organismal and cellular levels. The LP was analyzed with two local school districts' science curricula and results indicated a misalignment in terms of grade levels at which these topics were addressed: levels of organization, unicellular organisms, cell structure and function and protein function. Additionally, we suggest that by creation of a LP with a diverse group of participants and effective communication to education stakeholders, education reforms can be initiated.

	Gary Tarolli	Suzanne DeTore
Diane Emord Kate Foley		

Collaborative inquiry into effective models for science teacher professional development P-41-84-83-120

Research results from a collaborative inquiry group of science teachers in a high-needs urban high school that participated in a multi-year study to use high stakes student assessment data as a basis for the continuous improvement of their teaching practice.

Christiana Omoifo Martina Irogbele

Undergraduates Alternative Conceptions of Chemistry Ideas: A Nigerian Case Study P-402-725-724-759

Learning from the social constructivist perspective is the process of learners making sense of the world they live in based on their experiences. As a result many researchers agree that the most important thing that students bring to class is their conceptions. Research studies have also shown that when the cultural context of science is used as a basis for teaching some mismatches may arise in the classroom and especially in the minds of the learner. In Nigeria students enter science classrooms with their traditional worldview, which inevitably interacts with the Western Mechanistic Views'. This study is an assessment of undergraduates' alternative conception of chemistry ideas. The study is a survey. One hundred and twenty-five students participated. A two-tier multiple- choice diagnostic instrument was used. Data collected were analyzed using descriptive statistics and tests of difference of means. Results indicate 36 significant alternative conceptions in the three areas of chemistry content. Percentage of students with alternative conceptions. Significant interactions were found between gender and chemistry areas, and among gender, course of study and chemistry areas.

Sevinc Ongel-Erdal

Bilge Taskin-Can

Berna Gunhan

Developing a Self-Eddicacy Scale Towards the Use of Mathematics in Science Lessons: A Validity and Reliablity Study P-715-1515-1514-1545

Self-efficacy studies show that there is a strong connection among teachers attitude, beliefs and behaviors. Scales used to investigate teachers self- efficacy beliefs fail to determine self-efficacy toward the integration of two disciplines. In this study, an instrument, Self-efficacy Toward the Use of Mathematics in Science (STUMS), was developed in order to determine preservice science teachers self-efficacy toward the use of mathematics in their lessons. Instrument was applied to randomly selected (n=250) elementary preservice science teachers from a higher education institution in west of Turkey. The validity of the instrument is established by factor analysis. Results revealed 3 factors: Self Perception of Mathematics (SPM), Utilization of Mathematics (UM), and Mathematical Skills (MS). Reliability analysis produced Cronbach alpha of 0.88 (Alpha SPM=0.71, Alpha UM=0.75 and Alpha MS= 0.76). Results showed that the 18-item instrument appears to be a valid and reliable assessment of the use of mathematics in science lessons. However, validation of instruments is an ongoing process; therefore, we suggest further studies are needed to enhance the reliability and support the validity of the instrument.

Jonathan OsborneHanley PamRatcliffe MaryTwenty First Century Science - New Wine in Old Bottles?P-362-628-627-664Hanley Pam

Twenty First Century Science is an innovative UK high school science course that attempts to develop students' scientific literacy and teach science for citizenship rather than science for scientists. The course consists of a set of major explanatory themes of science and a set of ideas-about-science' that are taught through a set of topics which situate science in a contemporary context. This paper reports data from the evaluation of the pilot course and the major findings drawing on data collected over two years from classroom observations, a teacher questionnaire, a student questionnaire and interviews with the teachers. The findings show that the course is perceived by students to have greater relevance and has led to an improved disposition to study science further. However, the data would suggest that that assimilating the different goals of this course and transforming the pedagogy to match the goals and intentions of the curriculum is more of a challenge. The implications of these findings are explored.

Irene Osisioma Hedy Moscovici

Profiling the Beliefs of the Forgotten Teachers: An Analysis of Intern Teachers Frameworks for Urban Science Teaching P-353-706-705-740

The need to equip science teachers with knowledge, skills and habits of mind to face the challenges of teaching science through inquiry informed this study which analyzes the secondary science intern teachers' beliefs about inquiry before, during, and following a series of two consecutive science methods courses in an attempt to document the effect of such experience on their ability and willingness to infuse science inquiry in their science curricula. Nine science credentialing interns participated in the study. Data sources were their written reflections, and various assignments throughout the methods courses. Results suggested that their beliefs changed significantly after the science methods courses. The implications of the study to secondary science teacher educators and researchers were highlighted.

Trevor Owens

Climbing Our Family Tree: The Untimely Birth of Children s Books About Evolution, 1920-1955 P-341-586-585-622

Evolution was largely removed from high school textbooks in the period between the Scopes trial and the launch of Sputnik. Yet, this period saw the first children's books about evolution. By exploring these children's books and historical documents about their authors and publishers I demonstrate that the cultural history of evolutionary theory in American history is much more complex than has previously been noted. While the Scopes trial did mark a significant change in coverage of evolution in high school textbooks, it also marked the birth of literature for elementary age students about the subject. This study articulates a framework for the relationship between textbooks and general children's literature about science in the period as a means to initiate a discussion among historians about the place of both textbooks and children's literature in educational history.

Gohkan OzdemirElizabeth LewisDale BakerDevelopment and Validity of the CISIP Classroom Observation Instrument (COI)P-308-539-538-575

Abstract The purpose of this paper is to describe the validation procedure used to develop a classroom observation instrument (COI) in the Communication in Science Inquiry Project (CISIP). The supporting evidence for the validity has been documented through a relevant literature search, teacher feedback, field tests, and an on-going process of item definition and revision. The process of developing of three major drafts is described including the selection and placement of items on the various scales, use of classroom observations for practical use, alignment with the CISIP model and professional development workshops. The final draft of the COI consists of five scales, which are: inquiry, oral discourse, written discourse, academic language development, and learning principles. The COI contains of 43 items with a four-point Likert format. This observation protocol can be used nationwide in middle and high school clasrooms to determine to what degree science teachers integrate essential components of science instruction of the CISIP model.

Kira Padilla Carles Furió-Mas

A historical perspective of conceptions of chemistry teaching related to amount of substance concept P-596-1133-1132-1165

This research shows some misconceptions found in chemistry professors and which are related to the historical paradigm of how quantitative chemistry grew up. Historically there are two paradigms related to this concept: atomism and equivalentism, and we waited that all chemistry lecturers would be located into the atomist paradigm; however what we have found is that almost all chemistry lectures are into the equivalentist paradigm, so they think on mass instead atoms or molecules, and therefore they do not understand completely the amount of substance concept. What they say about this concept is related with amount of matter or mass, or simply they do not teach it because they have problems related with the name of the quantity. In the other hand we analyzed what chemistry textbooks mention about this concept and its unit, mole. What we have found is that it is just mentioned into SI tables and number of moles is written instead of it. So, that imply many students and professors are not going to be able to understand what amount of substance is. In brief, professors have some deficiencies in their historical knowledge about this concept and this brings them some conceptual and epistemological misconceptions.

Christine Pappas Maria Varelas Tamara Ciesla

Creating Illustrated Information Books in Science: Insights from Primary-Grade Children P-486-897-896-930

There has been a call for approaches that connect science learning with language and literacy, yet the use of and research on young children's writing/drawing in science instruction has been quite limited. This study focuses on the illustrated information books created by six young children (two each from a first-, second-, and third-grade classroom) as a culminating activity at the end of an integrated science-literacy unit on a temperate forest community, showing how these children's science understandings on various forest animals were expressed verbally and visually. Although the books were longer and more complex across grades, all of the books included relevant scientific ideas on the animal topics, and showed a range of strategies to orchestrate words and images to express the children's messages. The study contributes to efforts showing how to make visible the richness, complexity, and variability that are often embodied in children's texts, and, in this case, describing the ways in which primary-age children appropriate science discourse registers.

Eun Jung Park Arthur White

Student perception and conceptual development as represented by student mental models of atomic structure *P*-526-1422-1421-1453

Atomic structure has been an important concept in chemistry and in the history of science. Because of the abstract nature of the microscopic world of atoms and of quantum theory, difficulties and misconceptions in student understanding of atomic structure and the related theories have been discussed in many studies of science education. With a focus on student perceptions of atomic structure, this study analyzed student mental models for assessing student conceptions of atomic structure and related scientific models. In addition, the analysis of changes in student mental models can be a useful resource for making inferences about student learning processes, misconceptions, and conceptual development. This study explains that conceptual development in student mental models can be achieved, either by elevating models toward the higher levels of understanding (in-depth understanding of each concept) or by combining models to make a single mental model for atomic structure (through inter- relational thinking). The identification of alternative models revealed that many students had Bohr's orbiting electrons and orbital structure indicating the 3/1 level of understanding. In addition, this study points out that the understanding of quantum theory may serve as a hindrance or threshold for moving toward the target model for understanding atomic structure.

Soonhye Park J. Oliver

How Does the National Board Certification Process Facilitate Teachers' Pedagogical Content Knowledge Development? P-543-1005-1004-1038

This study examined how the National Board Certification (NBC) process, especially the portfolio creation process, influenced candidate teachers' pedagogical content knowledge (PCK). In a larger sense, this study aimed to construct a better understanding of how teachers develop PCK and to establish ecological validity (Kagan, 1990) of the National Board assessments. Qualitative research methods, most notably case study, were utilized. Participants were four high school science teachers who were either going through the NBC process or had previously certified. Data sources included classroom observations, interviews, teachers' reflections, and researcher's field notes. Data were analyzed using the constant comparative method and enumerative approach. Findings indicated that the NBC process affected five aspects of the candidate teachers' instructional practices which were closely related to PCK development: (a) reflection on teaching practices, (b) implementation of new and/or innovative teaching strategies, (c) inquiry- oriented instruction, (d) assessments of students' learning, and (e) understanding of students.

Eun Jung Park Arthur White

Characterization of student groups clustered by responses to course examinations related to atomic structure and mental models of atomic structure as represented in interview responses Q-526-1424-1423-1455

Atomic structure has been an important concept in chemistry and in the history of science. For the purpose of understanding student mental models of atomic structure in various assessments, this study first proceeded the q- type factor analysis with student responses to the questions related to atomic structure in three multiple- choice course examinations. Then, the clustered student groups by the q methodology were further explored by comparing student mental models of atomic structure as represented in interview responses. In order to characterize the three components clustered by student responses to multiple-choice course exams, individual characteristics such as gender, course grades, and mental models of atomic structure were further examined. CP1 is comprised of gender balanced students with a moderate level of atomic structure achievement and course grades in the C range. CP2 is comprised of all male students with high levels of atomic structure achievement and course grades in the A - B range. CP3 is comprised of all female students with a broad range of atomic structure achievement and course grades in the C or below range. Q methodology revealed the distinctive characteristics of CP2 as a group of students who are high achieving with advanced levels of understanding.

Meredith Park Rogers Sandra Abell

Implementing a science-based interdisciplinary curriculum in the second grade: A community of practice in action

P-717-1489-1488-1519

The purpose of this study was to explore the role that a collaborative teaching approach, referred to as a community of practice (CoP) had on a team of four second grade teachers' implementation of a sciencebased interdisciplinary curriculum. The theoretical framework guiding this study was phenomenological and data analysis followed a case study approach. The primary data source was extensive observation notes gathered over 10-weeks of team meetings, totaling 1 ½ -2 hours of observation per week. Secondary data sources included two 45 minute interviews with each teacher and one interview with the school principal. From our field notes we developed two vignettes that are used to help illustrate the community's collaborative practices. From our analysis of all the data, three themes emerged explaining the role of a CoP for this team of teachers. The themes included: 1) benefits, 2) their commitment to professional development, and 3) strength in numbers. From this study we learned that establishing a CoP was viewed as a necessary component of the team's implementation of their science- based interdisciplinary curriculum. Implications for encouraging preservice and inservice elementary teachers to develop CoPs in order to support their science teaching are discussed.

Cynthia Passmore

Argumentation in Modeling Classrooms P-718-1537-1536-1567

On several levels it can be said that the act of modeling in science is inherently an argumentative act. That is, in virtually all aspects of modeling, from developing a question to judging between competing models that might answer that question, an individual is engaged in persuasive acts. Those acts may be private or public. They may be mental, written or oral, but they are about judging ideas and making sense of them; convincing oneself or others that the ideas and ways of looking at and explaining a phenomenon are useful. These acts are what scientists find exciting. They are what make science intellectually interesting and challenging. Inviting students into this practice is one way to help them learn both the content and process of science. This paper introduces a framework that is attentive to the research on how people learn while simultaneously pushing for curriculum and instruction that engages students in elements of the practice of science. I explore how this framework can be used to foster argumentation by describing the theoretical underpinnings of the framework and using classroom examples to illustrate the utility of the framework for promoting argumentation.

Philip Patterson Mary Atwater

An Investigation of the Conceptual Change Process of Beginning College Level Physics Students Studying Newons Laws P. 226, 1426, 1425, 1457

P-326-1426-1425-1457

Students who successfully undergo conceptual change utilize certain cognitive strategies to accomplish conceptual change: intelligibility, plausibility, and fruitfulness; the literature also lists awareness, evaluation, regulation and reflection. This investigation utilized constructivist theory and employed the case study approach to explore the processes of conceptual change undertaken by students studying Newton's Laws in a beginning college physics course. The researcher utilized the Force Concept Inventory (FCI) to identify two concepts that were least understood. The researcher then randomly selected two groups of five students, each assigned to study one of the two misconceptions. The first misconception, the Hockey Puck misconception, asked the students to identify the forces acting on the hockey puck through its trajectory. During the process of conceptual change, two of the participants utilized awareness, evaluation and regulation, and reflection. The second misconception, the Elevator Misconception, asked the students to identify the forces acting on an elevator moving at constant speed. Only one participant utilized all four conceptual change strategies: awareness, evaluation, regulation and reflection.

Bruce Patton Anita Roychoudhury

Inquiry-based physics and student learning P-757-1300-1299-1331

This study conducted in an introductory physics course at a large university shows the effectiveness of inquiry-based pedagogy. A statistical comparison of various sections of the course shows that inquiry could help students learn the relevant content. A particularly interesting finding is the success of the course for the low performers. The analysis of the data also shows that students' frustration level has a complex relationship with their performance. There was sustained exploration of student performance via multiple measures, which showed varied levels of student understandings of the complexity involved in inquiry activities.

J. David Pearson

The role of reading, writing, and language in supporting inquiry-based science in our schools: Why we must lead with the science *P*-775-1671-1668-1698

In his presentation, Pearson argues, from the point of view of an ardent reading researcher, that for all too long, science instruction has been marginalized by an excessive reliance on text and vocabulary instruction to 'get the content on the table' for students at all levels, primary through secondary school. While still supporting a major role for reading, writing, and academic language (including vocabulary) instruction, Pearson asserts the claim (and presents data to support it) that both the science learning and the acquisition of language and literacy skills will be improved if our curricula and our classroom pedagogy lead with the science and ask reading, writing, and language to play a supporting role rather than a leading role. He outlines the fundamental principles of an NSF-funded project designed to accomplish just such a 'reversal' of curricular and pedagogical 'fortunes', and presents data on the efficacy of this approach.

Debby PeckPeter MorrisonDanny MarmenKaren SullengerIs What We Are Doing Science? -- Middle School Students' Perspectives of Scientists and Themselves Doing
ScienceP-517-1301-1300-1332

Science-in-Action is designed to track elementary students through their middle school years by including middle schools and their feeder elementary schools in the study. We wanted to know if over time more students would continue with the project. In this first phase we had approximately 60 middle school students compared to 110 elementary. We wanted to know what these middle school students though doing science was and how closely their pictured mirrored their ideas about scientists doing science. Further, we wanted to know what effect grappling with the activities and tasks we gave them would have on their thinking. What we learned is that these students did change their understanding of scientists work and that despite the fact that we gave them increasingly difficult tasks that at times were time consuming and somewhat boring, they did not drop the project.

Erminia PedrettiLindsay BakerIsha De CoitoMarie-Claire ShanahanEnhancing Teaching and Learning in Science through Scientists in School OutreachP-497-906-905-939

This research describes a large-scale study conducted over a two year period with the Scientists in School [SiS] Program and two school boards. Research goals were to: a) conduct an evaluation of the program, and b) explore the impact of SiS on teachers, students, principals and parents. We used a mixed methodology approach. Data sources included: workshop surveys (students n = 932, parent volunteers n=86, teachers n=50), principal surveys (n = 62), and long term teacher surveys (n=236). Teachers and students were also interviewed. Findings suggest that outreach programs emphasizing hands-on science enhance students' attitudes toward science, and inspire greater understanding and interest in science. Furthermore, outreach programs can provide professional development opportunities for teachers thereby enhancing teacher confidence.

Deniz Peker

Turkish College Biology Students Acceptance of Evolution P-696-1406-1405-1437

The purpose of the current study was to measure students' acceptance rate of evolution theory and creationist ideas. Total 159 college biology students enrolled in three different courses participated in this research. Two of the courses were freshman level general biology and molecular and cellular biology courses. The other course was a senior level evolution course. A pre- and post-course survey questionnaire was administered to see if students' pre- and post- course responses to the statements about evolution theory and creationism are significantly different. The results indicated that students' acceptance of evolution was quite high at around 80 percent in all three groups. The percentage of undecided students decreased after taking a biology course. The matched t-test results indicated significant changes in students' acceptance of evolution theory across all groups after taking the courses. One-way ANOVA results indicated that senior biology students' post-course survey scores were significantly higher than their freshman counterparts.

Nancy PelaezEileen LewisWriting an Effective Grant ProposalP-776-1673-1670-1700

This workshop is an introduction to grant writing for science educator faculty in science departments and for education research and science education faculty who work with discipline-based science faculty. The objective of the presentation is to enhance the proposal writing skills of the participants, enabling them to write more effective and successful proposals.

Erin Peters John Baek Brenda Bannan-Ritland

The Effect of Embedded Metacognitive Prompts based on the Nature of Science (4-Phase EMPNOS) on Metacognition

P-142-231-230-267

There are many unanswered questions about the ways to teach the nature of science to students. This quasi- experimental study measured the effectiveness of an intervention incorporating developmental metacognitive prompts based on the nature of science in an inquiry unit. The developmental portion of the prompts was based on Zimmerman's (2000) self-regulatory phases: observation, emulation, self-control and self-regulation. Four eighth grade classes (n = 97), two experimental and two control groups, participated in the study. A Metacognitive Orientation Scale Science (MOLES-S) and a Metacognition of the Nature of Science Scale (MONOS) were administered as a pre- and post-test to answer the research questions: Do control and experimental groups differ on science students' perception of the metacognitive orientation of the class? and What is the effect of 4-Phase EMPNOS on science students' metacognition of the nature of science? An Analysis of Covariance (ANCOVA) showed a significant difference between the control and experimental groups, F (51) = 1.942, (p d 026). A t-test performed on MONOS score gains for both groups showed a higher gain for the experimental group, t(69.142) = 2.069, (p d .042). The findings of this study give a clue to one method of addressing teaching of the nature of science.

Michael Peterson

The Causal Relationship Between Flexible Thinking and Deductive Inferencing P-685-1383-1382-1414

Over the last 50 years, domain knowledge has been shown to positively influence creativity. However, few studies have explored the impact of creativity skills on domain- relevant skills. This study examines the influence of flexible thinking on the deductive thinking of urban, private high school students (n = 40) in science. Data were gathered using group-administered deductive inferencing and divergent thinking assessments specifically designed for this study based on North Carolina's statewide physics achievement test. Analyses indicated flexible thinking tasks positively influenced students' science deductive inferencing, and that conceptual combining mediated between flexible thinking has a causal effect on deductive inferencing in science.

Marianne Phillips

Eugene Chiappetta

An Analysis of Twelve Middle School Science Textbooks for the Nature of Science P-344-596-595-632

Many science teachers rely heavily on their textbooks to teach science (Weiss, 1993). Science for All Americans (AAAS, 1990) and the National Research Council (1996) call for teaching students the nature of science. Teaching the nature of science supports successful learning of science content (Driver and others, 1996), and bridges the gap between practicing scientists and school science (Sorsby, 2000). Therefore, it is important textbook materials convey an accurate conception of the nature of science. The purpose of this study was to analyze the methods of science chapters from twelve middle 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). The majority of text analyzed continues to stress science as a body of knowledge, devoting a higher proportion of content to science as a way of investigating and science as a way of thinking, than in the past. However, many textbooks continue to devote little text to the interaction of science, technology, and society.

Teddie Phillipson-Mower

Building A Green Partnership P-755-1613-1612-1642

To change the course of human induced threats to the environment demands an environmentally literate global population. With the added urgency of recent world events, organizations, corporations, and public institutions have recognized the value of environmentally sound policies and have begun to implement green practices. In August of 2004, the Partnership for a Green City, was launched in response to a merger between a city and county government system and a strong commitment to becoming environmentally responsible and improving the health of its citizens. The Partnership is unique in that from the very beginning EE was not only included, but is embraced as the connecting and central factor of the program. The purpose of this paper is to outline the work of the Partnership, and more specifically share the development, goals, barriers, collaborations, and accomplishments of the Environmental Education Committee within the Partnership.

Molly PhippsShawn RoweJoseph ConePortable computers in a Public Science Museum:Findings from Phase One of a design based researchproject on iPods and PalmOnes.P-734-1547-1546-1577

This project is the first phase of a two-phase study testing the feasibility of incorporating hand-held, multimedia devices in a small public science center. Participants checked out iPods or PalmOnes to watch and listen to supplementary video and audio clips. While the devices were not universally accepted, most participants who used the devices responded positively to technology use in the visitors' center. This project follows a design-based research approach that acknowledges that multiple iterations of new educational content are required to create a high-quality learning tool that will be used by learners.

Wesley Pitts

Cultural and Transformative Practices in Laboratory Activities P-173-1407-1406-1438

In this study, the interactions among a laboratory group of five black female high school students, their chemistry co-teachers, and fellow classmates are examined during a chemistry laboratory lesson and workshop on pH. Although the study foregrounds the laboratory-class field as the central field of interest, interaction in the chemistry classroom, cogenerative dialogue sessions, and outside school are also explored so as to gain vital understandings of the culture (schema and practices) enacted in the laboratory-class. Observations through meso- and microanalyses of movements, interaction, and utterances that illuminate various aspects of the social, cultural, and symbolic capital enacted in the laboratory-class field and other surrounding fields provide data sources to describe successful and problematic patterns of cultural interaction and exchange cycles as the students carry out the workbench and other laboratory procedures in order to successfully complete the laboratory exercise.

Julia Plummer

Developing Students' Understanding of Astronomy in the Planetarium P-498-904-903-937

The National Science Education Standards recommend that students understand apparent celestial motion (patterns of motion of the sun, moon and stars visible from the earth's surface) by the end of early elementary school. However, little research has investigated children's knowledge of apparent celestial motion or instruction designed to improve understanding in this area. This project explores early elementary students' ability to learn these topics through instruction that takes place in a planetarium. The instruction used kinesthetic learning techniques: activities that use the students' own motions to help them learn about celestial motion. Pre- and post-interviews were conducted with participants from seven classes of first and second grade students. Students showed significant improvement in all areas of apparent celestial motion covered by the planetarium program, and in most areas surpassed the understanding of middle school students who did not participate in the program. The results of this study a) suggest that students in early elementary school are capable of learning techniques in the rich visual environment of the planetarium towards improving knowledge of these concepts.

Patrice PotvinMartin RiopelSteve MassonFrédéric FournierIntentional Conceptual Change in Question: Do Secondary School Science Students Know When TheyDon't Know?P-225-1111-1110-1144

The main goal of this research is to verify the capacity of students to estimate correctly in various contexts the scientific worth of the answers they bring to certain scientific questions. Many research initiatives in the field of conceptual change presume that answers given by students are always accompanied with certitude. This research offers the possibility for the students (n=755) to express doubts and also to express their level of confidence about their answers. It is believed that if students can make a good estimation of this value, and can express dissatisfaction towards some of their own ideas, then it becomes reasonable to consider that intentional conceptual is something possible. Results tend to indicate that students often overestimate the scientific value of their own conceptions, especially in cases where subject- matters hold many well-attested alternative conceptions and in cases where children practically never studied the topic. We conclude that the beginning of a teaching sequence might not be the best moment to try to initiate intentional conceptual change in the student's minds.

Chantal Pouliot

College students and scientific knowledge production: relationships to expertise and capacities to enact epistemological questioning practises *P*-281-465-464-501

This paper reports findings about college level students' relationships to scientific expertise in the context of the research they conducted over a semester on a variety of scientific controversies. Two teams (n = 6-8 students) investigating a scientific controversy were followed during a whole school semester. This study presents the analysis pertaining to one of those teams. The controversy was around purported risks associated with cellular phone use. Via an ethnographic approach I describe students framing of the controversy, notably their perceived relationships with 'expert actors', such as researchers and physicians. The results support ideas that students are intimidated by scientific expertise. Yet while our findings show that college students do tend to feel intimidated with respect to scientific expertise, they are also able to question certain aspects of that expertise. Hence, while intimidated, students still exercised a certain political astuteness. This study is concerned about how science education can better prepare students to participate in discussions and debates within science and society. The goals is to move science education further along the road towards a more 'empowering form of education', a kind of science education wished for, among others, by Roth and Désautels (2002).

Burkhard Priemer Stefan Kirchner

Students' Attitudes toward Open Inquiry Experiments in Physics P-429-763-762-797

Practical work in school and university has a long tradition. Hence, the accompanying research in science education is extensive and well documented. Foci of research were on aims and rationales, learning outcomes, assessments, epistemological beliefs, science concepts, types of laboratory work and much more. Despite this broad background, astonishing little is known of students' attitudes toward laboratory work. Often it was reported that students liked doing experiments in science but this usually only reflected general impressions and was rarely assessed systematically. This study addressed students' views of laboratory work in a methodical way by using questionnaires and interviews. Results show, for example, that students clearly preferred open inquiry tasks to expository work and rated their own learning outcomes higher when solving open-ended problems. This was true even for those students with lower achievements in physics. These students asked for additional help and support - but not for step-by-step instructions - before putting an experimental plan into action and when discussing and analysing their results. Results of the study can help to implement appropriate settings for student practical work in science.

Norm Price

Self-study of the Evolution A Deferred Judgment Questioning Discussion Mode in a Middle School Science Teacher

P-506-1492-1491-1522

This paper is a self-study of teacher thinking during the evolution of a deferred judgment questioning discussion mode which grew out of my experience with a biology curriculum that aims for content goals using ideas that are mostly student-generated. This curriculum challenged me to break my reliance on lecture and recitation (fishing-for-the-answer) and develop modes of interacting that were more open-ended but still converging on specific content goals. A discussion mode evolved, called sounding , which expands the role of student thinking in whole-class discussions. One stage of sounding is generative and required skills of deferring evaluation, producing generative questions, and analyzing student ideas. A second stage is evaluative and required skills in encouraging student evaluation of ideas. Sounding asks students to articulate their understandings and then to evaluate and modify them stimulated by ideas from the teacher and peers. Analysis of class transcripts indicates that the change in my teaching style did not happen all at once but rather over a period of months. This description of my path toward a constructivist mode suggests an evolutionary aspect to teacher change. My description of sounding may help teachers make constructivist methods more viable within a standards-based classroom.

Glenda Prime

Bradford Lewis

Obed Norman

Barbara Butler

Karen Benn- Marshall

Challenging Some Myths about Urban Science Education S-700-1439-1438-1470

This symposium will consist of 5 presentations that invite the science education research community to re-examine some of the widely held assumptions that undergird research on urban science education. The presentations are premised on the view that the prevalence of unexamined opinions about urban science education limit the contribution of the research to the amelioration of the problem of low achievement among the minority students who attend inner-city schools. Specifically we argue that these myths divert attention from the societal structural aspects of the problem. We make a call for greater clarity with respect to the concept of urban itself and suggest that it is often used as a euphemistic way of avoiding dealing with race. We challenge the idea that the solution to the achievement problem lies primarily in curriculum reform and teacher quality, and suggest that sociocultural structures impact students' identity and hence their achievement. We draw attention to the fact that differences in social positioning influence the way that Black children experience science, thus challenging the idea that with respect to science education equality of provision will produce equity of outcomes. Finally the popular myth about the representation of African American students in special education is scrutinized.

Rose PringleCirecie West-OlatunjiThomasenia AdamsAfrican American girls and science learning: How are they positioned in elementary science classrooms?P-446-1182-1181-1214

An examination of the educational status and trends in the United States reveal that Black students were less likely to take advanced science courses when compared to their White and Hispanic peers. Furthermore, National Center for Education Statistics [NCES] (2003) reports that while wide gaps in achievement exist along racial and ethnic groups there are also notable differences in performance when gender is examined. A review of the literature reveals that much research has been conducted on issues related to girls, African American achievements and the impact of socio-economic status. In this research, we explored the intersectionality of all three constructs within a population that has low rate of achievement in science. This qualitative study asked the questions, How do African-American middle school girls position themselves as science learners in relation to their gender and ethnic identities? and How do parents, teachers, counselors, and administrators positionalities toward African American girls impact their interest and achievement in science that the girls' constructed cultural, gender, and class identities formulate their positionalities toward science. Also, teachers' and parents' positionalities influenced the girls' perceptions, expectations, and support behaviors toward African American science learning.

Nantarat PuengpangVantipa RoadrangkaBronwen CowieChris EamesThai Pre-service Science Teachers' Science Process Skills, Views on the Nature of Science, and Attitudestowards BiologyP-431-766-765-800

This paper reports on a study into the learning of pre- service science teachers in an undergraduate biology laboratory class in Thailand. The study aimed to investigate three learning outcomes; integrated science process skills, views on the nature of science and attitudes towards biology. Three instruments were used to assess these learning outcomes; a Science Process Skill Questionnaire, a Nature of Science Questionnaire and an Attitude towards Biology Inventory. The questionnaires were in an open-ended format and the inventory adopted a rating scale format. All instruments were reviewed by four science faculty members and four science educators. Responses were analyzed by theme analysis and rating scale analysis. The respondents were thirty-six pre-service science teachers who enrolled in an undergraduate laboratory in biology course. They were asked to give responses to the questionnaires and inventory after participating in the course. The results showed that the pre-service science teachers had better skills in interpreting data and drawing a conclusion than identifying problems, formulating hypotheses, identifying variables and designing an experiment. Their views on the nature of science were mainly found to be in agreement to those discussed in the literature. Their attitudes toward biology were mainly found to be positive. The findings of this study were used to help design a teaching intervention for the course that would improve science pre- service teachers understanding of how to teach biology.

Ahmad Qablan Sherry Southerland

Understanding the Dynamics of Teaching for Sustainable Development at an American University P-134-222-221-258

Promoting education for sustainable development (ESD) in schools and universities has captured the attention of global community. The process of promoting ESD programs in universities represents difficult and complex task (Hungerford & Volk, 1990; McKeown, 2002). However, understanding the different elements that are involved in the activity of teaching for SD at the university level is needed to facilitate that promotion. Indeed, it is not well understood what contextual elements are likely to support or inhibit university professors in their attempts to teach for sustainable development. This study was designed to uncover the contextual elements that are involved in teaching for SD in a typical university classroom. A series of interviews with professors and students as well as classroom observations was used to collect the data for this study, the preliminary data analysis indicates that teaching for SD is complex and multifaceted. Furthermore, there are different contradictions and challenges that prevent university teachers from teaching for sustainability (i.e. university rules, classroom size, teacher's responsibilities, and unclear understanding of the sustainability concept itself).

Miia Rannikmae

Jack Holbrook

Developing and Evaluating a Sustainable, Socially Derived, Science Teaching Approach a Longitudinal Study of Teachers Q-639-1332-1331-1363

This study recognises the importance of promoting scientific and technological literacy (STL) among students and highlights factors influencing the effectiveness of this process. It examines, over the period 1999-2006, science teachers' ownership and acceptance of a philosophy of STL for the teaching of science subjects and describes a long term teacher professional development. The research objectives were: (1) to follow and document the sustainability of science teachers' change towards STL teaching, measured as an ability to develop and use socially derived teaching materials and establishing a student centred classroom environment; (2) to find categories which describe the science teacher's permanent change towards STL teaching and the factors influencing the process of professional development over a 7 year period. The structure of the consequence maps created by teachers to describe their teaching approach was used to distinguish three categories of teachers: subject learning activity based, with a dominance on facts and concepts; sequenced activity based , with emphasis on process skills; social issue based, including problem solving and decision-making strategies.

N. Sanjay Rebello

Consolidating Traditional and Contemporary Perspectives of Transfer of Learning: A Framework and Implications P-782-1685-1682-1712

A diverse set of theoretical perspectives has informed the study of transfer of learning. While transfer has traditionally been defined as the ability to apply what is learned in one context to a different context, over the last decade or so some researchers have expanded their view of transfer and have begun examining transfer from the point of view of knowledge construction rather than knowledge application, per se. Here we ask the question: Can these two seemingly different perspectives be consolidated into a broader overarching theoretical framework? If so, what will such a framework look like and what are its implications for research and instruction? In this paper we begin to address some of these questions and present the beginnings of a framework that we believe might provide a lens in examining transfer of learning.

Suzanne ReevePhilip BellLeah BrickerDavid KanterElizabeth LynchConnecting science learning to personal health:Understanding the influence of instruction, family, social
networks, and institutionsS-482-872-871-906

The research presented in this symposium suggests how cooperation between the learning sciences and health sciences might improve the long-term efficacy of existing health interventions, as well as generate possibilities for new types of interventions, by attending to the cognitive, social, and cultural bases associated with health-related decisions. We explore cognitive hypotheses for understanding descriptive and causal models of health, with the goal of promoting everyday health-related decisions. Through interventions, interviews, and observational studies, we discuss children's understandings of what makes objects and activities 'healthy' or 'unhealthy'; family health beliefs and interactions with health institutions; health beliefs of adults as influenced by ethnicity and education level; and outcomes of middle- and high school science curricula focused on nutritional energy balance and disease causation. We believe that a consideration of these various aspects realistically reflects the overlapping influences and settings encountered in daily life, and can aid health scientists and learning scientists both in understanding the behavioral, social, and lifestyle determinants associated with personal health and in creating a pragmatic vision for positive health interventions.

Michael Reiss Sue Dale Tunnicliffe

Dioramas as depictions of reality and opportunities for learning in biology P-447-798-797-832

A diorama is a careful siting of a number of museum objects in a naturalistic setting. Biology dioramas typically combine preserved organisms and painted or modelled landscapes. While expensive to construct they have tremendous educational potential. The literature on dioramas is surprisingly small. Here we focus on their potential as sites for learning science, specifically biology. Drawing on photographs of dioramas and conversations recorded at them in a number of countries, we examine the extent to which dioramas reflect or construct reality. We suggest that a useful perspective is to see them as telling stories. Visitors respond well to stories, and bring their own experiences, hopes and fears to them, but to maximise the educational potential impact of dioramas, the stories needs to be read with some care. Younger visitors can benefit from scaffolding, just as is used when introducing children to literatures that are at the upper end or beyond their present capabilities.

Leonnie Rennie Denis Goodrum

Toward a Framework for School Science Education in Australia P-767-1649-1646-1676

Over the last decades, considerable efforts have been made to improve the outcomes of school science education, particularly focused on ways to enhance the development of scientific literacy. Yet, the proportions of students choosing to study further science, and choosing science-related careers continues to decline in most Westernized countries. In Australia, a range of initiatives has been developed and implemented at national and state levels, and it is time to get a 'big picture' view of what is currently happening in science education in our schools. The aim of the Australian School Science Education Framework is to map initiatives by the various educational authorities, assess the extent to which there is complementarity of effort and activity, identify any significant gaps in policies and programs, and recommend actions to enhance the provision of science education and address priority needs.

Leonie RennieRachel SheffieldGrady VenvilleRosemary EvansRekha KoulLearning about Ecological Diversity in Urban Wetlands: A Scientific Literacy PerspectiveQ-360-624-623-660

This paper synthesizes the findings of two studies of schools each working on a project about ecological diversity in an urban wetland. One project examined problems and solutions relating to lake nutrification and the other investigated snakes and their importance in wetland biodiversity. The research focused on scientific literacy and explored how students' learning and experiences both in school and in field settings contributed to the development of scientific literacy. The research also examined pedagogical, organizational, and resource issues associated with the successful implementation of such projects. Parallel case studies combined qualitative and quantitative approaches to data collection over the period of each project. The outcomes of the projects were similar. Student motivation was high throughout, and they learned both science content and values from an integrated, inquiry-oriented curriculum. Considerable time and commitment from teachers and community leaders, and modest funding were significant factors in the projects' success.

Eric RiggsRebekka DarnerRussell BallietThe Influence of Environmental Management Internships on Native American High-School Age StudentInterns NOS ConceptionsP-531-1327-1326-1358

As part of an integrated program designed to increase the earth science expertise resident in Native American communities in Southern California, we have initiated an internship program for high school students. Participants work part-time in reservation environmental management offices on projects of concern to the tribe. To assess the impact of these work experiences on these students understanding of science and the connections between science and Native American culture, we have initiated longitudinal studies with our student participants. We use a semi-structured interview protocol based on published Nature of Science (NOS) instruments with added items about connections between Native culture and earth science. Initial interviews show that those students who succeed in the internships arrive with relatively sophisticated understandings of NOS. After two months in the internship program, we see growth in student understanding of NOS and the relationship between their indigenous culture and science. Our interviews reported here took place over our participants' summer break, so this change cannot be attributed to school learning, and is likely the result of the work experience. These results suggest that doing applied scientific research directly improves NOS understanding for Native American students and may be an especially valuable component of our program.

Joseph Riley	Malcolm Butler	Toh Kok Aun	Yap Kueh Chin	Но			
Boon Tiong	Boo Hong Kwer	1					
The Influence of Peer Discussion on Preservice Elementary Teachers							
P-177-1051-105	50-1084						

This study draws from conceptual change, social constructivist and andragogy theory to answer the following questions. Can knowledge of pre-service teachers' alternative conceptions be applied in instructional interventions to encourage conceptual change? Will pre-service teachers evidence conceptual change after involvement in discussions with peers holding different views on the same concept? Results of preservice teachers' responses to physical science, two- tier test items were used to assign them to discussion groups. Group members were then challenged to try to reach consensus through argument and persuasion. Concepts were tracked with pre-discussion, post-discussion and delayed post-tests. Discourse analysis was used to determine the type and quality of discussion within groups. While research has shown that children are often reluctant to abandon their alternative views, little research has examined the tenacity of these sam misconceptions in more mature learners or what influence andragogical approaches might have on their conceptual change.

Martin RiopelPatrice PotvinGilles RaîcheSteve MassonFrédéric FournierComputerized modelization process in physical mechanicsP-361-626-625-662

To make science laboratory sessions more instructive, we have developed a learning environment that will allow students enrolled in a mechanics course to be involved in a scientific modelization process by combining computer- simulated experimentation and microcomputer-based laboratories. The most original part of the environment is that it lets the students compare the simulated animation with the real video by superposing the images. Using this software with students lets us observe that they were able to use the software to produce adequate answers to questions concerning both previously taught concepts in physics as well as new theoretical ones. The students completed the experiment about twice as fast as usual and considered that the use of the software had resulted in a better understanding of the phenomenon. We conclude that it would be interesting to further investigate some of the benefits associated with this environment, particularly the acceleration effect and the equilibrium between inductive reasoning that we observed within this research.

Léonard Rivard Levesque Annabel

How is literacy enacted in science classrooms? Three case studies in minority language schools P-101-177-176-213

Language activities, such as talking, reading, and writing, are considered a fundamental and constitutive part of doing science. In the science classroom, teachers establish the linguistic and discursive boundaries for learning science while hopefully creating a milieu in which students are engaged with scientific texts using various language-based activities. In most Canadian schools, students are taught science in English, the majority language. However, in minority francophone schools, those in which science is taught in French, teachers wishing to provide a rich array of opportunities for developing literacy among students face considerable challenges. The problem investigated in this descriptive study was how literacy is enacted in minority francophone science classrooms. This descriptive study involved observing three different secondary science teachers while they taught an instructional unit on electricity. An observation protocol was specifically developed for the study that categorized different instructional/literacy events and types of textual material. The three case studies included a quantitative analysis of instructional/ literacy events, as well as find-grained analyses of the texts that students read and produced. The paper contributes to an important conversation among science researchers, particularly those from jurisdictions confronting disparities between science learners based on the language of instruction or on language heritage.

Ros Roberts Richard Gott

Evidence, investigations and scientific literacy: what are the curriculum implications? P-423-757-756-791

'Scientific literacy' has many definitions. Many consider that understanding evidence is necessary to participate in decision making and to challenge the science that affects people's lives. But is it possible to teach about evidence and does teaching in a lab transfer to students asking questions in the context of a local environmental issue? The research literature points to problems with such transfer. However, this research found that students who were explicitly taught the 'concepts of evidence', the ideas required to be able to conduct open investigations were more sceptical about the claims of 'safe' made by scientists in a local environmental issue. The experimental group also raised significantly more questions specifically about the evidence that lead to the scientists' claims: What evidence did they have? What tests did they carry out? They used the ideas they had been taught to question the quality of the data collected: How many sample readings were taken, where and when? Was the instrument sensitive enough, specific to the contaminant and with reliable readings? This paper describes the research as well as the curriculum and how it was taught before considering the implications for curriculum developers and teachers.

Charles Rop Toni Sondergeld

A River Runs Through It: Integrated Field Studies, Environmental Education And The Nature Of Science P-628-1274-1273-1305

This research examines the impact of integrated environmental field studies on K12 teachers' attitudes and beliefs about the nature of science and scientific inquiry. A River Runs Through It (ARRT) is an intensive inquiry- based summer field studies program of environmental education for teachers that focuses on the historic Maumee and Ottawa River watersheds in northwestern Ohio. The Views of Nature Science Questionnaire was administered before and after the ARRT program. Participants kept a field notebook, regularly reflected on their experiences, and participated in informal interviews. The researchers also wrote field notes, examined written artifacts, writing samples and written lesson plans the participants prepared. Results suggest that participants, as a result of ARRT, were surprised by the pleasure of inquiry, placed more emphasis on the creativity and imagination, and gained a wider, more integrated view of environmental education. Participants also said that, as a result of the program, they now understand scientific inquiry better and feel more confident in translating State and National Standards into practice,

Sara Rose Fouad Abd-El-Khalick

The Effect of Discussion-Intensive and On-line Problem Solving on Freshmen Students Understanding of Force

P-525-959-958-992

This study aimed to (a) assess the effect of augmenting web-interfaced homework with discussionintensive recitation sessions on student understanding of forces in introductory college level physics courses, and (b) understand how discussion-intensive recitations impacted student cognitive processes during problem solving. Participants were 150 students enrolled in two Freshmen calculus-based mechanics college level courses in two Midwestern universities. The study had a pretest-posttest comparison group design with student scores on the Force Concept Inventory (FCI) serving as the independent variable. Instruction in the participant courses differed mainly in the inclusion of discussionintensive recitation sessions centered on solving content-rich problems in small collaborative groups. Participants were administered the FCI at the outset and conclusion of the courses. Sub- samples of students in each course participated in three think-aloud interviews over the course of the study. During the interviews, students solved selected physics problems involving forces. The discussionintensive recitation sessions resulted in statistically significant improvements in students' conceptual understanding of forces as evident in differential improvements in FCI scores. Additionally, student problem solving skills in the experimental group were substantially improved over the course of the study as was evident by exhibiting more expert-like behaviors while solving problems.

Kathleen Roth Catherine Chen

Teacher learning from videocases of science teaching: A conceptual framework P-396-718-717-752

There is a growing consensus that the most effective teacher learning programs immerse teachers in practice- based inquiries that are embedded in real classroom contexts and focused on the content and curriculum teachers will be teaching. Video and computer technologies provide a new avenue for creating such practice-based programs. In particular, online, interactive videocases of teaching, which include videotaped lessons along with accompanying lesson plans, student work, student assessments, and curriculum materials, have the potential to support teacher learning. But how can video technology best support teacher learning from analysis of such videocases? And what kinds of teacher learning are best supported by videocase-based programs? The paper set addresses these questions and describes how online, interactive videocases are being used and assessed in preservice science methods classes and in a year-long inservice professional development program. This first paper in the set describes how a review of the literature was used to develop a theoretically-grounded, research- based conceptual framework. This framework guided the design, implementation, and teacher learning assessments in the two videocase-based teacher learning programs, which are described in papers 2, 3, and 4. The framework focuses teachers' attention on the content storyline and student thinking in science lessons.

Olga Rowe

Mathematics Content in a Public Aquarium/Science Center: Staff and Visitors Points of View P-727-1517-1516-1547

There is a growing demand to bring together science and math skills around live animal collections in zoos and aquariums as well science centers. The research reported on here is part of a larger project to highlight the hidden mathematics in live animal exhibits and exhibits on scientific research. As such it focuses on whether visitors believe they can learn math from exhibits or want to spend time on it. This project seeks to contribute to the field by examining visitors' and staff perceptions during all stages of adding mathematics content and activities to the museum exhibits on the floor. The research reported on here examines survey and interview data and reports on visitors' perspectives on the value of bringing math explicitly into the science center/ aquarium, how visitors view math, how staff view math, and staff perspectives on the value of bringing math explicitly into the science center/ aquarium. The findings include that despite the limited view on math, visitors see the science center/aquarium as a positive asset in their math learning. Visitors' and staff understandings of math, views on math, and beliefs about the exhibits on mathematics are discussed.

Patricia Rowell Joan Chambers

Discourse practices in science center programs for schools P-485-881-880-915

Many science centers offer programs designed specifically for schools, programs which are not open to the public. As part of a larger study, this report documents two workshops offered for primary children in different science centers as part of the centers' programs for schools. Research questions included: What messages about science are conveyed in the workshops? How, and by whom, are programs presented in the workshops? What is the nature of student participation in the workshops? Data sources include audio-tapes and field notes made during the workshops, interviews with the presenters, science center materials and materials specific to each workshop. An interpretive account of the discourse shaping each session is generated through analysis of the presenters' talk, with particular orientation to the representation of science, ways of participating in the workshop, and pedagogical focus. The study raises questions about the potential for science center school programs to contribute to formal school science reform.

Jeffrey Rozelle Anne Haley MacKenzie

Keeping the Faucet On: Summer Science Experiences and Summer Learning Loss P-460-877-876-911

Studies have indicated that the disparity in achievement on standardized tests between suburban and urban students results largely from the learning pace during summer months. The purpose of this study was to determine the relationship between students' at-home summer science experiences and achievement gains between the May and October administrations of the science portion of ninth- grade Ohio Proficiency Test (OPT). During the summer of 2002, students at a large urban high school were required to complete a summer homework assignment, which included the reading of one science-related novel and a related paper, along with a choice between 13 hands-on science experiences. A low, significant correlation coefficient (0.24, p < 0.1) was calculated between the number of experiences a student complete adequately and their improvement from May to October on the science OPT.

Stefan Rumann Elke Sumfleth

Enhancing Students Competencies on Scientific Inquiry in Chemistry P-694-1405-1404-1436

The purpose of the study is the evaluation of an inquiry- oriented learning environment in chemistry. The investigation is carried out as a longitudinal study with students aged 13-14 while the theme acids and bases' is introduced. A quasi-experimental design (experimental group vs. control group) is used to study the influences of inquiry-oriented and self-regulated group-work on knowledge and interest. In the pre-test relevant variables as e.g. interest, motivation and pre-knowledge are assessed and contrasted to post-test results. The teaching- learning situations at school are videotaped for controlling the teacher's behaviour and for analysing the students' discourses. Categories are developed to allow a quantitative analysis of the videotapes. The analysis leads to identify fruitful and ineffective learning situations and hence form a basis for improving the quality of science education. Even the effect size is quite small the results show that the students benefit significantly more from self- regulated learning and working on investigative tasks in small groups than from the traditional classroom situation. In spite of the positive influence on achievement of the inquiry-oriented learning environment the analyses of the videotapes underline the students' difficulties in interpreting the results of their experiments and linking them to their hypotheses.

Greg Rushton

Chemistry Teachers' Emerging Expertise in Inquiry Teaching: P-652-1316-1315-1347

The effects of an intensive two-week professional development institute on a group (n=7) of high school chemistry teachers conceptions and practice of inquiry instruction are presented. During the first week, the teachers carried out chemistry inquiry investigations under the supervision of a university science education faculty member who modeled several research-based strategies during the content sessions. A learning cycle approach (Predict-Observe-Explain) was consistently followed throughout the first week with the teachers taking the role of the student by making predictions, carefully observing chemical phenomena, discussing their ideas with peers, and writing scientific explanations. The teachers were then asked to develop their own inquiry lessons and individually lead 45-minute sessions with a small group of high school students enrolled in a summer enrichment program. Analysis of transcribed pre- and postworkshop interviews and written reflections indicate a significant improvement in each of the teachers conceptions and comfort using inquiry strategies in their own classrooms. Additionally, there was a significant increase in scores between the beginning and end of the workshop on a conceptual chemistry exam designed for high school students. Implications of the professional development model for future teacher training are discussed.

Lisa Ruth

Impacts of Reform-based Curricula and Pedagogy on Student Achievement in Middle School Science Classrooms P-652-1308-1307-1339

This paper investigated the impact of reform-based curricula and inquiry teaching strategies on student achievement in eight middle school teachers classrooms after their participation in an inquiry professional development institute. Student achievement was assessed with standards-based pretests and posttests. Results indicate substantial learning gains by all classes, with several teachers classes realizing very large gains. Effect sizes ranged from a minimum of 0.57 to 3.18. These teachers were also videotaped while enacting standards- based lessons in their classrooms. These videotapes were analyzed using the Reformed Teaching Observation Protocol (RTOP). The RTOP scores were compared to each teacher s calculated effect size to determine if a relationship existed between the level of reform-based instruction and student achievement. RTOP scores were not found to be a predictor of student learning gains, but were found to be associated with teachers who embraced reform-based methods attained during the summer institute. The effect sizes for this study provide evidence for the success of inquiry- based instructional strategies on standards-based assessments. Teachers who presented lessons considered highly reformed had effect sizes as high as or greater than those who continued to utilize more traditional methods of teaching, when student population differences were taken into account.

Jon SaderholmNate MitchellTom TretterCritical Thinking Skills of Expert TeachersQ-484-1119-1118-1152

This study investigates the critical thinking of accomplished teachers and explores which of two commonly used critical thinking measures are most appropriate. One approach to identifying and measuring critical thinking abilities of teachers is to identify a group of teachers who have demonstrated strong competence in this important trait in the context of their profession. National Board Certified Teachers (NBCTs) are such a group. Critical thinking has been a topic much discussed in most areas of education for decades. Research indicates that the level of critical thinking ability among teachers varies greatly. Many teachers feel that they are not properly trained to teach critical thinking. Critical thinking is not only being encouraged at a post secondary level, but also at the K-12 level. In fact, the two major science education reform documents identify critical thinking skills as essential components within science curriculum. For teachers to help students become critical thinkers, it is reasonable to postulate that the teachers themselves must be accomplished critical thinkers.

Sheraton New Orleans Hotel • New Orleans, LA

Troy Sadler

Learning Science through Research Apprenticeships: A Critical Review of the Literature P-71-313-312-349

Apprenticeship learning experiences, wherein learners work with expert mentors in authentic contexts, offers a model for science education consistent with sociocultural theory but quite different than most science classrooms. Graduate education has a long history of using apprenticeship research to enculturate students, but programs to engage secondary and undergraduate students in science are also emerging. An important question raised by this trend is what are these students learning through research apprenticeships? This report investigates the question through a critical review of empirical literature related to science apprenticeships with the aim of 1) providing a comprehensive picture of the field's current state; 2) establishing clear directions for future research in this area; and 3) exploring how student experiences in these contexts can inform science education more broadly. Twenty- nine empirical reports published between 1961 and 2006 are reviewed and critiqued. The studies explore widely varying outcome measures including views of science, interest in science careers, science competencies, and understandings of the nature of science. Reported results suggest that apprenticeship learning contexts tend to favorably impact this array of variables; however, several methodological concerns are identified. Implications will be discussed concerning how this research base can be improved and what questions remain unanswered.

Philip Sadler	Kathy Williams	Kathleen Fisher	Bryce Battisti
Programmatic Assessment	t: Tools for Informed R	estructuring of Curriculum	
S-130-1333-1332-1364			

In this symposium four presenters describe diagnostic tests in two areas, programmatic assessment in biology at the college level and in assessing learning in physical, earth, and space sciences K-12. At college level, we are measuring gains in conceptual knowledge by assessing students (2100 so far) at the beginning and end of several courses, including upper division courses for biology majors and lower division courses for biology majors and non-majors. At the K-12 level, test items are tied to the standards in physical, earth, and space sciences. In diagnostic tests, incorrect responses (distracters) reflect common alternative conceptions. The statistical properties of diagnostic items are completely different from items in traditional multiple choice tests designed to measure content knowledge. The most striking observation with diagnostic assessment is how consistent students are with respect to their firmly held, naive beliefs. Student scores on diagnostic tests are typically low (~35-45 points out of 100) because of the attractiveness of the distracters. For this reason, student gains are reported more often than actual student scores. We find that gains are usually achieved with advances in education and maturity, but they change slowly and are also influenced by the nature of the instruction.

Yavuz Saka Sherry Southerland

The Interaction of Personal and Contextual Factors during the Induction: Shaping the Enactment of Science Reform P-375-700-699-734

The goal of this study is to gain an in-depth understanding of individual beginning teachers' induction experiences, and how such experiences shape these teachers' attempts to teach in ways that are mindful of science education reform. As a means to a better understanding of the changes that occur within the teachers, we specifically focus on changes in beginning science teachers' sense of self-efficacy and their pedagogical discontentment, and how these factors play out in shaping the actions involved in their teaching during this fundamentally important first year of induction into the profession. Most previous research has chosen to focus either on the personal or contextual aspects of induction; with these objectives in mind, we argue that it is at the intersection of the personal and the contextual that we can discern crucial information. Thus, our research employs a theoretical frame (cultural-historical activity theory) that requires an emphasis on the interaction of both of these. Multicase studies were conducted in which we followed two novice science teachers during the 2005-06 school year. We argue that information and suggestions gleaned from this effort may assist us to better prepare preservice teachers and support inservice teachers.

Kate ScantleburyRowhea ElmeskyElizabeth McKinleyBambi Bailey

Rose Pringle Gale Selier

Re-visioning Science Education from Feminist Perspectives: S-208-343-342-379

This special symposium focuses on issues relating to women in science education by using auto/biography and auto/ethnography. The presenters examine how those challenges have changed, or remained consistent, since women's entrance into the academy. Women in science education are placed in a juxtaposition of gender roles and gendered career roles. The symposium's contributors span a temporal and spatial continuum and focus on how a variety of issues relate to those paradoxes for academic women in science education. The topics include: discussing how their engagement with science impacted their career trajectories and re-direction from science to science education, the relationships of cultural and racial factors on career trajectories, the dialectical relationship between women's privatelpublic lives and their agency (collective and individual) in the academy and its enactment within academic fields.

Kelly SchalkAnn SmithJ. Randy McGinnisAmy HendricksonThe Effects of the Undergraduate Teaching Assistant Experience in a Large Enrollment IntroductoryMicrobiology CourseP-152-246-245-282

There has been a concern in higher education regarding developmental opportunities for scientificallytrained workers and scientifically-literate citizens. This study supports an Undergraduate Teaching Assistant (UTA) experience as a way of actively advancing undergraduate students' skills for success in science fields. The UTA experience is defined in this study as: a pairing with a Graduate Teaching Assistant (GTA) in lab sections to guide students during lab work and active learning assignments. The UTA experiences included data interpretation, use of technology, library research, and moderating on-line and face to face discussions. We employed a mixed methodological approach including triangulated data from the GTAs and undergraduate students in addition to the UTA self reports. Data collected via WebCT were from Likert Scale and rubric instruments in addition to weekly UTA journals and short answer responses. Analysis revealed that 24 science majors' performances in communication, laboratory research and technology skills, as well as leadership and self esteem were enhanced after a semester-long UTA experience. This finding supports the UTA experience as an effective active learning strategy to promote the development of undergraduates' knowledge and skills for a career in science or the science education profession.

Lawrence ScharmannMike SmithJonathan OsborneGeorge GriffithViews of the Nature of Science from Biology, Philosophy /Theology, Pre-service Instruction, InternationalPerspectives, Scientists, and a (Kansas) Classroom TeacherS-774-1669-1666-1696

One of the most active topics of current research in science education is a host of issues related to the nature of science (NOS) and NOS pedagogy. Much of the concern for this topic arises from the ongoing battle between scientists/science educators and members of the social conservative movement/religious right in the United States. Some individuals in these two loosely defined groups typically hold conflicting worldviews, resulting in different views of what is and is not science. In contrast, other scientists/science educators, theologians, and religious academics espouse views that are much more in keeping with influential scientists such as Gould (1997), who espoused a view of science and religion as complementary but Non-overlapping Magisteria . Some have appropriately argued (Cobern, 2000) that education should be much more about reasoning than about categorizing, e.g., this is science, this is not. In keeping with this suggestion, some of the presenters at this session (Smith and Scharmann) have argued that a fruitful classroom approach may be to focus on identifying various claims as more scientific or less scientific. Regardless of the approach, however, the classroom teacher faces every day the decision of what to include and what to exclude in instruction. Thus, in practice, the question of What is science? cannot be avoided.

Melissa Schen Anita Roychoudhury

The Development of Scientific Reasoning in Biology Majors Q-743-1577-1576-1606

Scientific reasoning is a skill of critical importance to those students who seek to become professional scientists. Yet, there is little research on the development of such reasoning in biology majors. In addition, scientific reasoning is often investigated as two separate entities: hypothetico- deductive reasoning and argumentation. Using Lawson's Classroom Test of Scientific Reasoning (LCTSR) and Toulmin's argumentation pattern (TAP), this study addresses both these issues and establishes a baseline of scientific reasoning development in biology majors through their engagement in introductory coursework. This study identifies trends of initial improvement in the student's first two quarters of introductory biology coursework, as well as correlations between scores on the LCTSR and TAP. Factors in instructional emphasis and assignments are examined for correlation with scientific reasoning development.

Rebecca Schneider Barbara Hug

Environments for learning: Engaging teachers and students in inquiry curriculum P-582-1102-1101-1135

Learning environments, such as inquiry science, that encourage all students to actively engage in activities and conversations are considered essential to promote students' deep understanding of important science concepts. To support teachers, researchers are designing curriculum materials intended to encourage student participation in science. However, developers are challenged to create materials that help teachers enact inquiry, yet, leave space for teachers to participate as professionals during enactments. In addition, teachers' participation with students may enrich the learning environment. In order to design innovations that engage both students and teachers, a better understanding of how teachers participate, with their students and in creating instruction is needed. In this exploratory study, one teacher's classroom enactments were examined as she used reform-based materials for three inquiry science units in her 7th grade classroom. Analysis was focused on classroom events and conversations that illustrated students' and the teacher's participation. To explore the role of tasks and teachers in encouraging student engagement in science, the nature of the tasks, the level of student and teacher engagement in the science, and the teacher's level of engagement in instruction were examined. Implications for the design of materials to facilitate teacher participation and engagement will be discussed.

Carolyn Schroeder Timothy Scott Homer Tolson Tse-Yang Huang Yi-Hsuan Lee

A Meta-Analysis: The Effects of Teaching Strategies on P-604-1290-1289-1321

The presenter will discuss a meta-analysis of current research in effective science teaching strategies. The purpose of the analysis is to examine investigations of the effectiveness of various science teaching strategies carried out over the past 25 years. The meta-analysis addressed the question: What teaching methodologies have been shown to improve student achievement in science? Strategies investigated in the studies were divided into eight categories: (a) Questioning strategies, (b) Focusing strategies, (c) Manipulation strategies, (d) Enhanced materials strategies, (e) Testing strategies, (f) Inquiry strategies, (g) Enhanced context strategies, (h) Instructional media strategies. The results provide a basis for suggestions for teachers to improve the learning and academic performance of students in K-12 science so that they are prepared for post-secondary success. The findings of this study are being used to develop a lay publication to share the results with educators across the state and to provide the criteria for a rubric to evaluate instructional and professional development materials. The lay publication and the rubric will be made available to attendees.

Elisabeth Schussler

Examining Plant Reproduction in Children's Science Trade Books P-503-1393-1392-1424

Recent trends in education include the use of children's science trade books for instruction. While these books are widely used, debate focuses on what students learn from them. This study analyzes how plant reproduction is shown in trade books about plants. One hundred six books about plants underwent a content analysis. Forty three of the books presented no information about plant reproduction. Twenty five gave no explanation for the fruit/seed production that occurred. Sixteen of the books showed pollinators or fruit / seed, but never linked them. Only 22 books mentioned pollination as a mechanism for fruit / seed production; even fewer mentioned fertilization. Analysis of the books identified four potential misconceptions: pollination confused with fertilization, flowers die before the fruit forms, ovule confused with egg, and the term pollen dust. Based on this study, students using trade books about plants will either gain little information about plant reproduction, or may only learn that fruit / seeds are produced from flowers and that pollinators play some role in this process. If the correct book is chosen, they may learn about pollination or fertilization. Teachers need to closely examine trade books about plants and should add instruction to supplement the text.

Christina SchwarzBeth CovittMin-Jung BaeYovita GwekerereDeveloping Pre-Service Teachers' Professional Knowledge with Curriculum Materials Analysis TasksP-234-1176-1175-1208

Curriculum analysis, modification, and enactment are central tasks in teacher practice. This paper presents an approach for helping pre-service teachers understand the centrality of curriculum use within teacher practice and begin learning about and engaging in principled curriculum analysis and modification. In particular, we designed and implemented several curriculum materials analysis tasks in three elementary science methods courses. Our analysis of classroom talk and behavior around one task (aimed at analyzing materials with respect to learning goals) indicates that pre-service teachers were involved in sustained engagement with the task. Pre-service teachers discussed how the materials met their personal goals for teaching, content knowledge around the learning goals, and how the materials met the learning goals. We also observed rich discussions about whether the materials could meet some but not all the learning goals, whether activities could move towards the learning goal, the function of lessons in a sequence designed to meet the learning goal, and the teacher s role in modifying lessons. This sustained engagement provides evidence that pre-service teachers were willing to see curriculum materials analysis as relevant to their future teaching practice and that they were actively building their professional knowledge around using curriculum materials for effective science

Renee' Schwartz

Beyond Evolution: A thematic approach to teaching NOS within other biology contexts P-620-1187-1186-1219

This study reports how NOS is explicitly taught and assessed in the context of a biology course taken by elementary education majors. The course assumes a thematic approach to NOS instruction throughout multiple units. Teaching about NOS within the context of science content courses has been recommended for helping future teachers learn the content of NOS and experience the pedagogy of teaching NOS within science contexts. It is recommended that undergraduate science content courses respond to the recommendations in order to develop college students' NOS views. We continue to see examples of addressing NOS within the context of teaching evolution, but have far fewer examples of embedding NOS in other biology subjects. This report provides details of explicitly addressing NOS throughout three units of a biology content course for preservice elementary teachers (genetics, molecular biology, integrated investigation of a human condition). I also describe the effectiveness of the instruction on student conceptions of NOS. Instruction included objectives, explicit and reflective activities, and assessments. Data include pre/post VNOS/VOSI questionnaires, journals, and exam responses. Results demonstrate improved understanding of targeted NOS aspects. More importantly, students demonstrated increased and appropriate application of science examples from throughout the course to support their NOS views.

Sheraton New Orleans Hotel • New Orleans, LA

Kathleen Schwille Karen Givvin

Use of videocases in preservice teacher professional development: ViSTA modules P-396-1435-1434-1466

This second paper in the series provides an application of the conceptual framework outlined in Paper 1. The specific context is the Videocases for Science Teaching Analysis (ViSTA) project, which is developing six online modules for use in preservice teacher education. Each module includes two videocases of science teaching, and gives instructions for specific tasks, guiding preservice teachers to analyze each case using the student thinking and science content storyline lenses. Throughout the module, preservice teachers also deepen their science content understanding about a specific topic, chosen because of its difficulty and conceptual importance for student understanding. Modules are designed for use within university methods courses, and provide an example of how science content learning can be integrated with pedagogical and pedagogical content learning for preservice teachers. Measurements of the effectiveness of these modules are described in Paper 4.

Philip ScottJaume AmetllerJudith Kleine StaarmanNeil MercerDialogic Teaching in Science ClassroomsP-327-565-564-601Neil Mercer

Previous research has indicated that by engaging students in dialogue, teachers can explain ideas, clarify the purpose of activities, 'model' scientific ways of using language and help students understand new, scientific ways of investigating and accounting for phenomena. However, little is known about how this kind of interaction can best be generated and sustained, and in what circumstances it offers most value. One of the aims of the current research project, funded by the UK Economic and Social Research Council, is to evaluate the kinds of teaching strategies which encourage and maintain dialogues with students leading to meaningful learning of scientific conceptual knowledge. A second aim is to compare the strategies used by elementary and secondary school science teachers. We have collected and analysed a range of data from schools in the UK, including video-recordings of sequences of science lessons, interviews with teachers and students, students' written work and teachers' assessments. Building on the authors' previous research on the role of language in classrooms and teaching and learning processes in science classrooms, we will draw on these data to focus specifically on the question: What constitutes dialogic teaching' in upper elementary and lower secondary science classrooms?

Gale Seiler Dana Johnson

Identity, coteaching and becoming yourself in science: The story of an African American preservice teacher P-213-350-349-386

Schema and practices related to science teaching are largely acquired from White, male, Euro-centric science and schooling. What does this mean for an African American female (preservice teacher) while coteaching with a White male? We provide video and narrative evidence of her science teacher identity re/construction in the development of a personally engaged pedagogy. This concept acknowledges the multiplicity of identity, even in science, and brings all of one's experiences into the classroom. Further, we show that coteaching with another who demonstrated his multidimensional identity created opportunities for the student teacher to do the same, although their identity collages were worlds apart.

Gale Seiler Phillip Sokolove Salar Sanjari

Collaborative study of active learning in a college Biology course Q-213-1085-1084-1118

A Biology professor, an Education professor, and an undergraduate Biology major worked together to compare two different active learning versions of an introductory college Biology course and their relationship to student learning. Time spent on various activities in each course version was coded using real-time and video recording of class sessions. Other aspects such as types of student-teacher and student-student interactions were also examined. An innovative special discussion section designed to give direct student input to the course instructor was also implemented. Additional qualitative and quantitative data sources complemented the coding system to create a rich picture of the active learning components of each course version, and these are compared with student perceptions and student learning outcomes. The involvement of coreseachers from differing departments and levels in higher education represents a new approach to improving teaching performance of college faculty and the learning of students in all disciplines.

Steven Semken Carol Butler Freeman

Cognitive and Affective Outcomes of a Southwest Place-Based Approach to Teaching Introductory Geoscience P-540-993-992-1026

Place-based teaching (PBT) leverages sense of place with cross-cultural, interdisciplinary, experiential curricula that may better engage students with rich senses of place, such as American Indians. Meaning and attachment, cognitive and affective components of sense of place, can be used as metrics of PBT effectiveness. A Southwest-based undergraduate geoscience course, integrating Indigenous ethnogeology, was piloted for a diverse class (n=31) in fall 2005. Cognitive and affective outcomes were assessed pre- and post- course with published, validated surveys of place attachment (PAI), place meaning (PMS), content knowledge (GCI), and attitudes toward science (VASS). Scores were analyzed with non-directional dependent samples t-tests. Place attachment increased significantly [t(26) = 2.94, p < 0.01] for Arizona students. Place meaning increased significantly [t(26) = 7.17, p < 0.01] for all students. Content knowledge increased significantly [t(26) = 4.19, p < 0.01] from a pre-course GCI mean of 42.3 ± 13%, equivalent to that of students nationwide, to a post-course mean of 51.3 ± 12%, exceeding the national post-course mean. VASS scores improved from 'folk' toward 'expert' understanding of science. PBT enhanced both components of sense of place, and effectively imparted geoscientific knowledge and habits, to all students in the course, including minority students.

Gökhan Serin Ali Eryilmaz

Examination of 7th Grade Students' Curiosity Level with respect to Some Real-Life Events of Physics P-223-366-365-402

The purpose of this study was to find out students' curiosity level with respect to real-life events related with Archimedes principle, pressures of solids, liquids, and gases and Bernoulli principle. After that some relationships between students' curiosity and individual characteristics as well as factors affecting students' curiosity were examined. The sample of the study was 7th grade students from five public schools. A total of 194 students were participated in the study. To measure students' curiosity level, a curiosity survey was developed. There were 81 items that are statements of real-life events related with Archimedes principle, pressure concept and Bernoulli principle. Students are asked to rate the items on a scale 3 (much), 2 (moderate), 1 (little), and 0 (none). The scale shows the curiosity level. The analysis showed that students in the successful group have a higher curiosity level than the students in unsuccessful group. It is observed that girls are more curious than boys. Students who like science course are more curious than students who like science course a little bit. There is a significant correlation between students' curiosity and achievement. Moreover, students' curiosity is significantly correlated with the variable of 'loving science'. Finally, it is observed that the most interested items were related with health.

Eulsun Seung Lynn Bryan Mark Haugan

Development of Knowledge for Teaching; the Matter and Interaction (M&I) as a Novel Physics Curriculum P-627-1214-1213-1246

Matter and Interaction (M&I) has recently adopted as a novel introductory physics course that focuses on the application of a small number of fundamental physical principles to the atomic and molecular nature of matter. In this study, we examined the process of four physics teaching assistants (TAs)' development of knowledge for implementing the M&I course from the time they engaged in an M&I content and methods workshop through their first semester as teaching assistants for the course. Through a qualitative, multiple case study research design, data was collected from multiple sources: non-participant observations, digitally recorded video, semi-structured interviews, TAs' written reflections, and researchers' field notes. Data analysis consisted of within and cross- case analyses. Data analyzed using the constant comparative method. TA training workshop and self reflection contributed in developing the participants' substantive knowledge of M&I. Pedagogical content knowledge related to instructional strategies, curriculum and students' learning was developed through the participants' teaching practice. The results of this study will contribute to not only the quest to identify the nature of professional knowledge for science teaching but also future preparation of the innovative introductory physics course as well as other college level science courses.

Ashraf Shady

Cogenerative Dialogue as a Tool to Expand the Students Agency P-173-1408-1407-1439

In an era of assessment-driven educational practices, it is essential to identify how evaluation methods, educational practices, and policies might affect the interest of urban students in the learning of science. This paper explores teaching and learning in a low-track urban science classroom in which most of the students are African-American, and from low-income homes. The study focused on the implications of the current educational practices on teaching and learning of science in a low-tiered eighth-grade classroom. As the teacher/ researcher in the study, I used cogenerative dialogues as a tool to improve my teaching as well as to expand the students agency. I argue that the current educational reform with its assessment component truncates the students agency, and portrays a limited view of the purpose of education, and how the cultural and social capital of the students can be used as a resource for learning. The research employed autobiographical reflection, the sociology of emotions, and cogenerative dialogue as tools to examine how the structure, the social and historical dimensions manipulate the students agency.

Marie-Claire ShanahanErminia PedrettiLindsay BakerIsha De CoitoImproving Underrepresented Students' Affective Response to Science through a Hands-on OutreachProgramP-350-1084-1083-1117

This study describes results from a large-scale study conducted with the Scientists in School [SiS] Outreach Program and two large school boards. This component of the study aimed to explore the responses of elementary school students (n = 811) from typically underrepresented groups (girls, lowachieving students, and English as a Second Language (ESL) students). In particular, it explores affective issues such as enjoyment, interest, role modeling, and career choice in science. Results suggest that students in typically underrepresented groups responded strongly to the program. Girls found the program particularly enjoyable and reported that it provided positive science role models. Students at schools with high ESL populations also reported higher levels of enjoyment and reported that the program helped get them excited about science. Students at lower achieving schools also report high levels of enjoyment and, like the girls, noted the opportunity for positive science role modeling.

Ajay Sharma

Observing Teacher Agency in a Science Classroom in India P-661-1524-1523-1554

The proposed paper narrates a story of science teaching in a rural middle school classroom in India. This story comes out of an ethnographic study done in 2005 in a government middle school in a village in the central province of Madhya Pradesh in India that looked at how science was taught and learned in a 8th grade classroom. Subscribing to a sociocultural perspective, the paper focuses on the teaching practices of a science teacher engaged in teaching school science according to a government prescribed curriculum to a 8th grade class. Based largely on ethnographic field-notes of the science classroom, the analysis adopts dialogic event as the basic unit of analysis. Results highlight the potential for personally meaningful and relevant science teaching that is possible even in otherwise bleak and unsupportive scenario, if a teacher enacts his agency to contingently circumvent his own limitations and negotiate the existing constraints and affordances to create apposite conditions for learning of science for his students. The analysis also indicates, however, that owing to the extant teacher professional and school science discourses, the teacher unfortunately could only achieve limited success in his endeavor to teach science well.

Jerome Shaw Sam Nagashima

Science Taught, Science Learned: Patterns of Performance in an Elementary Reform Initiative P-184-322-321-358

This paper examines patterns of student learning as measured by locally developed performance assessments embedded within inquiry-based units of instruction implemented in a multi-year, multi-district, NSF-funded science education reform initiative. The sample consisted of scores from 834 fifth grade students on three performance assessments given in a participating district's 14 elementary schools during the 2004-2005 school year. Mean scores were used as the basis for comparison. The results showed the majority of students achieving at the proficient level, as defined by initiative-developed rubrics, across all three assessments. Statistical analyses indicated significant underperformance by Blacks and Hispanics on one of the three assessments, and by males and Special Education students on all three of the assessments. No significant effects were found on any of the assessments for socio-economic status and being an English Learner. Overall, student level demographic variables explained only a small proportion of the variance in the scores for all three assessments. The results indicate the efficacy of the initiative's reform model, one that includes aligned curriculum, instruction and assessment along with coordinated teacher professional development on those components. The results also support the use of performance assessments over selected response assessments as viable measures of inquiry-based science.

Hsiao-Ching She Ya-wen Liao

Fostering Scientific Conceptual Change and Scientific Reasoning through a Web Learning Program P-410-730-729-764

This study examines the effects of a web based learning project with the basis of Dual Situated Learning Model (DSLM) and scientific reasoning theories on middle school students' conceptual change and scientific reasoning involving atom. Results indicated that students made significant progress from pre-, post- to retention, regardless of Atomic Achievement Test (AAT), Scientific Reasoning Test (SRT), and Atomic Dependent Reasoning Test (ADRT). In addition, students' use of the level of scientific reasoning progress from Generativity (G) to Elaboration (EL) after learning, and Justification (J) and Explanation (Ex) also appeared more frequently after learning. For the quantity of conceptual change also demonstrate that the mean scores of Progress (PG) is the highest from pre- to post-flow map across ten interviewing questions. The mental representation of atom structure also move from simple shape and composition to more sophisticate and accurate models after learning the program and even after three months of the learning. The results demonstrated that students' conceptual change can be promoted as well as their scientific reasoning ability through uniting both scientific reasoning and conceptual change into adaptive web-learning environment.

Rachel Sheffield Grady Venville Leonie Rennie

Learning Communities or Science Classrooms? A Comparative Case Study of Science Learning Q-417-738-737-772

The outcomes of learning community approaches to teaching and learning in the middle years of schooling have been hotly debated in educational research fields in recent years. The purpose of this research was to explore the role of classroom context on student learning of science in both a learning community classroom and a more traditional, science classroom. This comparative case study of community- based, science projects is informed by a worldly interpretive framework' that recognises and embraces the importance of classroom context on different approaches to curriculum. The contrasts evident between the two approaches indicate context can affect the learning to be focussed either on bounded discipline-specific knowledge or, alternatively, on issues and problems that transcend disciplinary boundaries.

Daniel ShepardsonBryan WeeMichelle PriddyLeon Walls Jon HarborMountains and Rain and Sheds and Towers: StudentsConceptions of WatershedsP-47-95-94-131

The purpose of this study was to investigate students' conceptions of watersheds. The Watershed Task was administered to 915 students from 25 different classrooms at different grade levels in different community settings. Student responses were inductively analyzed to identify students' conceptions. From this analysis four conceptions emerged: conception 1, watershed as a natural process consisting of a developed hydrologic cycle; conception 2, watershed as a natural process containing elements of the hydrologic cycle; conception 3, watershed as the natural storage of water; and conception 4, watershed as a human-built facility for storing water. The complexity of the hydrologic cycle varies across the conceptions. Conceptions 1 and 2 emphasized mountainous terrain, topography with high relief and elevation, and stressed a single river or stream; whereas conception 3 centered on a lake or pond. Thus, students' conceptions were primarily built upon topography and the hydrologic cycle. Conception 4 appears to be a word meaning association. It reflects the human storage of water; water is stored in a 'shed' or 'tower'. The only statistically significant differences were grade level by conception 1 and community setting by conception 3.

Sonya Sherrod Ratna Narayan

Flip the Inquiry Coin: Fun Activity or Meaningful Learning Experience? P-267-445-444-481

In this qualitative, interpretive study, we describe how pre service teachers engaged in inquiry-based activities in a basic Physics course designed for future educators. The research question investigated was: what impact did participation in grade appropriate, inquiry-based activities in PHYS 3400 have on the participant EC-4 pre service teachers? The participant pool consisted of six female Caucasians enrolled in the Bachelor of Science: Early Childhood Teacher Certification EC-4. A constructivist framework guided the data collection and analysis. Data collected included audio and video tapes of the class, interviews with the participants, field notes, and the participants' self stories and portfolios. Preliminary results revealed that participating in the inquiry-based activities illowed the pre service teachers to experience science content in a manner that engaged them without intimidating them. Participants also reported increased confidence in their ability to teach science in early childhood classrooms. However, the acquisition of tools and strategies to teach and the seeing and doing of inquiry did not always translate into an effective understanding of the content matter taught. This study has implications for classroom teachers and teacher educators

Todd Sherron Carol Flecther Jim Barufaldi

The Effects of Professional Development on Science Teaching Practices P-68-886-885-919

The science education reform movement emphasizes the importance of professional development as a means of improving student science achievement. Reformers have developed a vision for professional development based upon intensive and sustained training around concrete tasks that is focused on subject-matter knowledge, connected to specific standards for student performance, and are embedded in a systemic inquiry context. Researchers used measures from the National Science Foundation Teacher Enhancement program as well as a 35 item Grade 4 science field test to examine the relationship between professional development, teaching practices and student performance. Number of courses completed in Science Teaching methods was by far the most powerful individual teacher factor included in the HLM models.

Minsuk ShimBetty YoungKathleen GuglielmiPaul Bueno de MesquitaMeasuring Elementary Teachers' Readiness to Adopt Inquiry-Based Science PedagogyP-283-470-469-506

Assessing elementary teachers' readiness to learn and use inquiry/discovery pedagogy in science is critical to enhance positive change, as readiness is known to be the powerful predictor of future behavior. Based on the Transtheoretical Model (TTM), a stage theory of behavioral change developed in the field of psychology, the Teaching Science TTM survey was developed to assess elementary teachers' readiness to adopt the inquiry- based pedagogy. Knowledge of stages of readiness to change behavior allows a match of interventions, such as those in professional development sessions, needed to enhance positive change. Ninety-six teachers in a Northeastern state participated in this validation study. Factor analyses were used to identify the underlying dimensions. Multivariate analysis of variance was used to see the differences in processes among teachers at different stages of change. Evidence supported the validity and reliability of the scales used in the survey.

Namsoo ShinShawn StevensCesar DelgadoJoseph KrajcikJames PellegrinoUsing Learning Progressions to Inform Curriculum, Instruction and Assessment DesignP-645-1361-1360-1392

Introducing an emerging science discipline such as nanoscience into the grade 7-12 classroom creates many challenges. As emerging sciences tend to be interdisciplinary in nature, changes in instruction, assessment and curriculum development are required. In particular, this interdisciplinary nature requires that a greater priority must be placed on fostering connections between ideas from many different scientific topics. In this study we report on efforts to assess students conceptual understanding within the nature of matter. In so doing, we have characterized connections between concepts and ideas that students make successfully as well as those with which they have difficulty. We have used this data to create a multi-dimensional progression of ideas that we used to validate a potential learning progression for the nature of matter. The critical conceptual links can be translated into both classroom and large-scale assessment strategies/ materials. In addition, the work informs both the curricular structure and instruction by providing insight into how students connect ideas from other science disciplines with a core scientific concept.

Yoonjoo Shin Seung Choe

Pseudo Student Talk(PST)- A Teacher's strategy to make students participate in the class Q-704-1483-1482-1513

In most classrooms, teachers talk more than students. Teachers have been thought to be knowledge -donors and Students knowledge-acceptors so teachers' talks were thought to be more important than students'. But student talks are very important too.

Margaret Shroyer

Cecilia Hernandez

Systemic Reform in Teacher Education and Its Impact on K-16 Science Teaching and Learning P-158-251-250-287

This paper documents a collaborative systemic reform initiative, supported through long-term professional development, to improve K-16 science teaching and learning. A longitudinal case study of this reform, involving science educators, scientists, and K-12 teachers of science, is presented to trace the impact of professional development initiatives on K-16 science teachers, science teaching practices, and K-12 student learning in science. The evidence from this case study suggests substantial impact on teaching and learning including K-16 teaching practices, teacher education program reform, and expanded opportunities and learning for K-12 students and teacher education candidates. Four conclusions are presented: (1) significant educational change requires extensive and continuous time, resources, professional development, and implementation support across the system; (2) deeper understanding and implementation of the science standards are developed through extensive and meaningful work with the standards; (3) the influence of teacher development initiatives on teachers, teaching practices, and student learning can be minimized or enhanced by curriculum, assessment, and accountability measures; and (4) teacher development efforts need to be centered on student learning.

Yael Shwartz	Aaron Rogat	Joi Merritt	Joseph Krajcik
The Effect of Classroo	om Practice on Students U	Inderstanding of Models	
P-510-1304-1303-133	35		

Science instruction focused around modeling can help learners develop deep understanding of subject matter and the nature of science. Despite its importance, students typically do not develop an understanding of modeling, and many teachers lack strategies for supporting their students in the practice. This research examines a teacher's and her students' developing understanding of models and modeling by taking part in an 8-week 6th grade chemistry unit that focuses on the particle nature of matter, models and modeling. The unit was developed as part of IQWST: an inquiry-based curriculum development project. The curriculum closely integrates content learning goals, with scientific practices. Modeling learning goals as well as meta-knowledge of models and modeling were highly specified. To assess the change in teacher practice and the change in students' meta- knowledge of models and modeling, various types of data were collected: Pre and post students and teacher interviews, videotapes of lessons, students artifacts, and open-ended pre-post assessment items that involved the use of models. Preliminary findings suggests an improvement in students understanding of models and modeling. The change in the teacher understanding of modeling, as well as a change in her attitude toward modeling as a classroom practice is also observed.

Marcelle SiegelMyron AktkinGloria BanuelosPatricia CalderaKatherine NielsenClaudia Scharff

Inquiring with English Learners: Connecting Instruction, Asssessment, and Scientific Inquiry P-214-353-352-389

A great need exists for research and resources that will help teachers to engage English learners (ELs) in scientific inquiry, support ELs' investigations and explanations, and fairly assess ELs' learning. In this paper, two studies were combined to investigate these issues. In the first study, professional development was designed to integrate science and language instruction. In the second study, inquiry-based assessments were modified to extend the inquiry focus while also improving equity for English learners. The studies both examined ways that the five essential features of inquiry (NRC, 2000) were instantiated through instruction and assessment. In the first study, three levels of science and language integration were identified. Not every lesson adequately addressed essential features of inquiry, however several examples described powerful inquiry experiences that integrated language development. In the second study, eleven types of modifications to assessments were identified that aided English learners. Ways that the changes in the assessments decreased the language factor and enhanced the essential features of inquiry were demonstrated.

Ryan Sikkes Kathie Black

An Exploration of Science Teachers' Misconceptions of Science Concepts P-272-484-483-520

The purpose of this study was to examine practicing teachers' understandings of the use of misconceptions in building new scientific knowledge as well as their personal understandings of common scientific misconceptions. Ninety-one participants from a non-random sample of teachers who teach science at the grades 5 through 8 levels completed a paper-based questionnaire and six teachers were subsequently interviewed. The data collected included demographic data (gender, age, teaching experience, and educational background), a self-assessment of personal content knowledge, a survey of classroom practices utilized, and a series of science ideas that were evaluated as either true or false by the participants. Various relationships between these data were identified. It was found that age and teaching experience had no effect on participants' abilities to identify misconceptions, but that gender did with men being able to identify misconceptions easier then women. In addition, participants with more scientific backgrounds were better able to identify misconceptions. Conclusions include the need for explicit instruction about the role of misconceptions in pre-service teacher education and addressing the issue more fully professional development opportunities for science teachers.

Eli SilkChristian SchunnMari Strand CaryEvaluating A Design-Based Learning Curriculum in Terms of StudentsScience Reasoning GainsP-245-405-404-441

An evaluation was undertaken of a 6-week design-based science unit for teaching electricity concepts to 8th grade students. The outcome being evaluated was student transfer of learning from the design-based unit to standardized, multiple-choice items measuring science reasoning. These sorts of items are traditionally very difficult for students from low socio-economic backgrounds, so the evaluation took place with students (N=170) from an urban school district, over 80% of whom qualified for government subsidized free or reduced lunch. There were significant gains of science reasoning from a pre to post assessment. In addition, the design classrooms exceeded national and international benchmarks on TIMSS Grade 8 released items. The assessment scores of the students from the short design-based unit also compared favorably to an established 3-year inquiry-based curriculum and outperformed a 3-year textbook-based curriculum. These results support the use of design as an alternative method for teaching science to students from diverse backgrounds, as design is both consistent with current science reform efforts calling for students to do science and design-based units can have effects large enough to observe with traditional accountability measures.

Jonathan Singer Randy La Cross Robert Feller

Re-conceptualizing the structure of professional development: Integrating content, pedagogy and practice through middle school and university partnerships P-652-1331-1330-1362

The goal of this paper is to describe the impact of a professional development program on middle school science teachers' ability to enact pedagogical strategies, learning technologies and materials that align with the current science education reform movement advocated by AAAS, NRC, and NSTA. This professional development program consisted of a 16-day summer institute plus sustained support throughout the following academic year. The paper presents findings from 3 years of enactments (2004 06), and describes the design elements including the yearly adaptations as well as mechanisms for linking the assessment of the Institute to measurable classroom practices. Data sources for the final component of this paper include post participant reflective essays, pre/post interviews and video-taped instructional observations. The reflective essays involved the teacher-participants responding to a set of three open-ended questions that corresponded to the three main components of the Institute (morning content course, team practice teaching to MS students, and pedagogical reflections). The findings provide support for the institute's design and theoretical framework. Teacher enactment data analyzed through the Reformed Teaching Observation Protocol showed significant scores skewed toward inquiry teaching strategies. Scores from two separate enactments indicated significant improvement in the use of inquiry pedagogies by the teacher participants.

Sheraton New Orleans Hotel • New Orleans, LA

JoElla Siuda Maria Varelas Christine Pappas

Affordances of Class Murals for Learning Science in Urban Primary-Grade Classrooms P-516-938-937-971

This study focuses on a particular mode of the visual arts, the mural making that took place in primarygrade classrooms where children and teacher engaged in two integrated science-literacy units, Matter and Forest. We explore the ways in which various classroom communities of young learners (first, second, and third-graders) viewed their world, as they designed their class murals to represent aspects of that world. In both units, the murals took different shapes and forms in the six classrooms, were made with different materials, and over different timelines. The murals gave us windows into children's thinking and meaning making, and they also played an important role in the development of the children's scientific understandings. As children considered positions, sizes, colors, materials, and orientations of the entities they wanted to depict in their class murals, they built connections among these entities and discussed processes involving them. The murals were a semiotic tool that also let the children imbue empathy and emotions to the scientific ideas they were constructing. The developing knowledge did not belong to individual children; as children worked with each other at the various phases of the mural activity, their meaning embodied the voices of those around them.

Scott SloughJoel BryanJohn MilamThe Design of Converging Lens Computer Simulations and Their Effect on Image FormationUnderstandingP-669-1496-1495-1526

As computer technology increasingly enhances the teaching and learning of all science disciplines, computer simulations, in particular, have become exceptionally beneficial in physics education. As with any educational innovation, the manner in which in which physics instructors integrate computer simulations into their instructional practices directly effects its effectiveness. However, the simulation design may also be an important factor in evaluating its impact on a student's conceptual development and understanding. This paper examines the effects of three differently designed converging lens simulations on students' predictions and subsequent understandings of how images are formed by converging lenses, specifically in relation to outcomes when portions of the lens or image are covered. Implications for further development of computer simulations and implementation into instructional practices result.

Lara Smetana Randy Bell

Computer simulations to support science instruction and learning: A critical review of the literature P-624-1217-1216-1249

Broadly defined, computer simulations are computer generated, dynamic models of the real world and its processes. They present theoretical or simplified models of real-world components, phenomena, or processes, allowing learners to observe, explore, recreate, and receive immediate feedback about real objects, phenomena, and processes that would otherwise be too complex, time-consuming or dangerous. For over two decades, researchers have explored the effectiveness of computer simulations for supporting science teaching and learning. This body of research indicates that simulations can help students develop content knowledge and process skills as well as promote more complicated goals such as inquiry and conceptual change. In studies where instruction using computer simulations has been compared to traditional instruction, research shows that, overall, interaction with computer simulations resulted in measurable achievement gains. This research also indicates that simulations are equally, if not more, effective than traditional methods. A need exists for a recent comprehensive critical review of the literature on the impact of computer simulations in science teaching and learning. The purpose of this paper is to present such a review with the goals of summarizing what we currently know and providing guidance for future research.
Leigh Smith Kendra Hall Roni Jo Draper Marta Adair

It s All about the Test : Promoting Science Literacy in an Era of Accountability P-686-1417-1416-1448

During a process of cooperative inquiry, classroom teachers and university science and literacy educators worked together to develop two integrated instructional units designed to support children's facility with expository texts (using text structure instruction) specific to the science content being taught, striving to improve the students' ability to read, comprehend, critique, and communicate about specific science concepts. Although this research examined the processes of developing and implementing the interdisciplinary curricula as well as the impact of the instruction on the students, this paper describes the successes and challenges associated with the implementation phase of the project. Teachers identified the benefits of using science texts in developing literacy skills and learning science vocabulary. They also stressed the process of recording data during learning activities. Barriers to implementation were described by teachers as largely contextual issues, including the pressures of mandated accountability measures and time constraints. Limited science content knowledge also proved to be a challenge in implementing the interdisciplinary units.

Julie Smithey Elizabeth Davis

The Development of Preservice Elementary Science Teachers' Knowledge about Learners' Science Ideas P-648-1259-1258-1290

Well developed pedagogical content knowledge is necessary for effective teaching. However, there is little work suggesting how the beginnings of PCK develop for preservice teachers and what kinds of experiences might support that development. This study follows a class of preservice teachers through an elementary science methods course. Data for this study are course assignments designed to foster attending to learners' science ideas. Results describe a range of ideas that constitute the beginnings of PCK for preservice teachers. Different activities foster thinking about different aspects of attending to students' ideas. For example, interviews with children provide exposure to actual ideas but also lead to over generalizing by preservice teachers. Responding to images of inquiry supports preservice teachers in considering the difficulty of their students' ideas. Finally, reflections after teaching science lessons seem to provide the richest opportunities for considering students' science ideas in a variety of ways. Implications for teacher education and research into beginnings of PCK are considered.

Youngjin Song

Let me tell you a story: a preservice science teacher s pedagogical content knowledge in a school-based internship course P-374-661-660-695

The purpose of this study is to gain a better understanding of a preservice science teacher's pedagogical content knowledge (PCK) from stories based on her experiences in a school-based internship course. One in-depth case study was conducted with the participant, Anna (a pseudonym). Multiple data sources were used including (1) semi-structured interview transcripts, (2) participant observation notes, and (3) documents (field notes, her lesson plans and classroom documents, reflective journals, and her assignments from university classes). Recognizing narrative inquiry as a way of understanding teachers' knowledge, data were analyzed utilizing narrative analysis suggested by Polkinghorne (1995). The constructed stories provide a rich backdrop for understanding what the participant knows about specific science concepts and how she represents that knowledge to her students. The preservice science teacher showed that she had (a) proto PCK, (b) limited repertoire in terms of presentations and strategies, and (c) insufficient knowledge of students' learning and concepts. Implications for both science teacher education and research methodology are suggested.

Edward Sosu Angus McWilliam

Mixed method approach to education research: a case study of teacher commitment to environmental education

P-368-642-641-678

This paper argues that a mixed method approach is useful in understanding the complexity that underlies issues in education and education research. Using a case study of teacher commitment to Environmental Education (EE), we discuss how issues highlighted by one method are explored with another, and how different methods can help us expand our understanding of the problem situation. The mixed method approach used here was in three phases. In the first phase, we examined general factors that affect the teaching of EE through interviews with teachers. Findings were content analysed to elicit salient beliefs which were used to construct a questionnaire. The second phase made use of the questionnaire to explore the extent of these beliefs using correlation and regression analysis. The third phase aimed at expanding our findings by applying a Soft Systems Methodology (Checkland & Scholes, 1990) to explore and model a system that will improve teacher commitment. Results indicate different methodological approaches brought up different aspects of the issue and thus expanded our understanding of the problem. It also highlights the pitfalls of adopting such an approach.

Sherry Southerland Alejandro Gallard Martinez

Examining Teachers Conceptual Hurdles to Science For All P-133-800-799-834

In this research we focus on what science teacher educators need to know to be able to facilitate teachers' professional development regarding inclusive science teaching. The goal of this research is to identify science teachers' beliefs/conceptions that play a significant role in shaping their understandings of and attempts to enact inclusive science teaching practices. We examined the workproducts for 19 teachers enrolled in a graduate course focus on diversity in science teaching and learning and checked our emerging understandings via a series of interviews with a subset of these teachers. As we analyzed these data we noted the superficial difficulties the teachers identified themselves, as well as describing those beliefs and conceptions that prohibited or allowed for the teachers' understanding and enacting of equitable science instruction. Themes emerging from the data include: the view of science learning as a strictly cognitive endeavor, teachers' own ethnocentrism, deficit mentality about non mainstream students, their families and their communities, and the rejection of equitable science instruction in favor of equal science instruction, a conception that was closely tied to teachers' belief in schooling as a meritocracy. The implications of these conceptual hurdles for science teacher education are discussed.

Sherry Southerland Scott Sowell D. Ellen Granger Murat Kahveci Yavuz Saka

Working to measure the impact of professional development activities: Offering an instrument to quantify science teachers pedagogical discontentment Q-133-214-213-250

Working to measure the impact of professional development activities: Offering an instrument to quantify science teachers pedagogical discontentment This research focuses on science teachers' pedagogical discontentment, a construct that describes teachers' lack of satisfaction or contentment that occurs when teachers recognize a mismatch between their own pedagogical beliefs and their actual classroom practices. We present an instrument to be used to measure teachers' pedagogical discontentment, an instrument that eventually will allow science educators to better describe the affective states of teachers entering professional development experiences. To inform this instrument, we conducted interviews with practicing elementary and secondary science teachers to provide us with first-hand accounts of how teachers discuss aspects of their current science teachers. Factor analysis identified that 30 of these items fell out along 5 subscales, each with a high internal consistency, confirming the theoretical categories identified in the interviews. The revised 30-item measure was administered to a sample of 200 elementary, middle and secondary teachers. The revised scale is described along with the psychometrics of this instrument.

NARST Annual International Conference 2007

Marilyne Stains Vicente Talanquer

Classification of Chemical Reactions: The Effect of Expertise P-33-818-817-852

We investigated the patterns of reasoning used by undergraduate and graduate students to classify chemical reactions represented at the microscopic and symbolic levels. We were specifically interested in the identification of the representational features that students use to build a classification system and the categories they created. Understanding student thinking in this area is crucial since classification is one of the central aims and means of chemistry and since a large percentage of school chemistry problems rely on the application of appropriate classification schemes. Research data has been collected in the form of clinical interviews with students enrolled in general chemistry, organic chemistry, senior and graduate level chemistry courses. Our results indicate that the level of expertise and the type of representation of chemical reactions affected the type of categories created, the nature of features that students considered to build a class, and the role that these features had in the classification process. Undergraduate chemists, regardless of their level of expertise, often based their categorization judgments on surface features, while graduate students classified reactions according to chemical properties.

Lynn Stephens John Clement

Analyzing the Use of Teaching Strategies in a Model Based Curriculum: Promoting Expert Reasoning and Imagery Enhancement in High School Students P-506-1514-1513-1544

In this study we document the use of important teaching strategies in classroom tapes and attempt to cast them in a form that will optimize their usefulness for teachers and curriculum developers. From expert think-aloud protocols, we have identified a number of strategies for evaluating and modifying mental models. Analyzing lessons from a model-based high school science curriculum to see whether this set of strategies might be used, we find the use of analogies, extreme cases, running explanatory models, and Gedanken experiments, and the implicit use of several expert imagery enhancement strategies. Our overall purpose is to refine concepts for learning and teaching processes and to create new terminology for understanding implicit strategies at work in lesson structures. Video case studies of classrooms using the curriculum provide exemplars indicating that when the strategies are suggested in a curriculum and presented in a way that enhances their imagistic potential, students can use the expert thinking strategies as part of their learning process. In the cases analyzed in the several prongs of this study, the teaching/ learning strategies we have identified appear to be powerful ones for experts, curriculum developers, and students.

Donna SterlingWendy FrazierMollianne LogerwellKaren DunnHelping Uncertified Science Teachers Survive Teaching and Focus on Student LearningP-601-1155-1154-1187

The purpose of this study was to test the effect of various support factors on the success and retention of uncertified, inservice science teachers. With the current shortage of science teachers, school systems are forced to hire teachers with little training or experience teaching. The New Science Teachers' Support Network (NSTSN) was designed to help uncertified, inservice science teachers teach successfully and remain in the profession via university-school district partnerships. Using a mixed- methods experimental design, 37 new teachers in two large school divisions were randomly assigned to a treatment or control group for two years. The NSTSN provided teachers assigned to the treatment group with professional support in the form of instruction in the methods of teaching science, in-class coaching support by experienced science teachers, a website, and mentoring by fellow teachers and science professors. Data were collected from the control and treatment groups through online surveys, interviews, focus groups, observations, and analysis of artifacts. Support provided by the NSTSN had a positive impact on teachers' classroom management, planning, and instruction. Additionally, the students of teachers in the treatment group performed better than the students of teachers in the control group as measured by state tests and student grades.

Shawn Stevens Elizabeth Davis

New Elementary Teachers' Knowledge and Beliefs about Instructional Representations: A Longitudinal Study

P-234-1181-1180-1213

The challenges faced by new elementary teachers are daunting, as they are usually responsible for teaching most if not all subjects to their students. Teaching science is often considered to be one of the more difficult aspects of their work, as they usually possess little science content knowledge. Therefore, how they develop the skill to represent science content well is a critical step in their development as science teachers. This study is part of a longitudinal study that follows a set of elementary teachers through their first few years of teaching. In particular we investigated how new teachers evaluate and adapt instructional representations embedded in curriculum materials and how these change over time. We find that with experience, new elementary teachers exhibited a growth in the complexity with which they make their evaluations of representations. This increase in complexity maps to the development of their PCK for science teaching. A parallel growth of content knowledge was also observed as they gained experience, thus illustrating the complexity of the relationships among content knowledge, PCK, and teaching experience.

Shawn StevensNamsoo ShinCésar DelgadoMolly YunkerFostering StudentsUnderstanding of Interdisciplinary Science in a Summer Science CampP-683-1433-1432-1464

In this study, we present the effects of a two-week interdisciplinary science camp for middle school students. The curriculum was based upon results from our previous research with a population of students from the same school district, which suggested some specific deficiencies in students' understanding in the areas of size and scale, structure and properties of matter and forces and interactions. The results indicate that the camp was beneficial to the students' learning regardless of gender and ethnicity. Since this type of experience has been shown to influence student learning even over long periods of time, student science achievement over the following school year is monitored.

Nicholas Stroud

Is this science? A pilot student-scientist partnership program P-61-1380-1379-1411

In order to provide students opportunities to participate in authentic science experiences, four eighth-grade students were partnered with four astronomy graduate students to complete a 12-week research project. In its pilot phase, this student-scientist partnership program resulted in mixed experiences for the student participants. Out of the four partnerships, only two successfully completed the project, mostly due to practical issues. Both students who completed the project experienced significantly different science practices in their scope, authenticity, and depth. These experiences are explicated through the lens of participatory science, with successful practices defined as those that allow students to participate in a culture of science.

Nicholas StroudRachel ConnollyZohar RisLearning and Teaching Science in Practice: Design of a high-school science internshipQ-61-1497-1496-1527

Over the course of four years, we have developed a unique summer internship program for high school students. The internship is unique in its placement (a museum), its focus (social interactions between interns and their peers, scientists, and visitors), and its recognition of teaching as a significant aspect of science. In this poster, we describe the historical development through the three design elements of (1) cognitive apprenticeship, (2) participatory science learning, and (3) inside view of science.

Carol Stuessy Claire Hemingway

Online Professional Mentoring: How Do Plant Scientists and Student Research Teams Communicate about Students Scientific Investigations? P-309-929-928-962

Scientific Inquiry Through Plants (SIP) is an interactive online learning community supported by the Botanical Society of America. Middle school through college students explore science through hands-on inquiry projects, mentored online by volunteer plant scientists. Wonder of Seeds was the first inquiry unit developed and field-tested by a team of plant scientists, science researchers, and K-12 teachers. Seven scientists mentored 42 student research teams at four field sites. Student research teams entered project data in electronic journals and communicated with peers and scientists through an electronic discussion board on the SIP website. In this study, data from the field test was used to assess strengths and weaknesses of the protocols for data entry and dialog. Analysis of responses among scientists, student teams, and peers revealed patterns of discourse among the groups. Scientists offered encouragement, questions, advice, scientific information, and anecdotes. Student teams provided information on research progress, asked direct questions, sometimes provided additional information when asked for it, but rarely made conclusions or linked data from their experiments to their conclusions. This paper provides details of the discourse between scientists and student research teams and describes improvements in the site that resulted from the analysis.

Fani StylianidouRoni MalekMichael ReissPupil attitudes to science and scientists:Results from a UK and Ireland survey in Einstein YearP-128-645-644-681

As part of the evaluation of Einstein Year in 2005, we undertook a questionnaire-based study of attitudes towards science and scientists among 11-14 year olds across the UK and Ireland. We used an adapted version of the large, well-constructed questionnaire in the current international Relevance of Science Education (ROSE) study. A total of 10,111 usable questionnaires were returned. The results show pupils have a generally high level of interest in health/body context related topics but a low interest when it comes to the knowledge context. A slight but consistent drop in interest level is shown across all statements as age increases. Pupils have an overall positive perception of the impact of science and technology on society and a good attitude to scientists and their work. However, the exceptions are worrying when considered in the context of school pupils aged 11 to 14. The disagreement with scientists being' normal and attractive', agreement with having to work hard', and agreement with being brainy' all might be factors that could be off putting to a typical pupil in deciding whether or not to choose to study science subjects.

Karen Sullenger Marie Cashion

Science-in-Action: Implementing a New Approach to Informal Education P-517-1291-1290-1322

Science-in-Action is a longitudinal, research program designed to provide elementary and middle school students with an interactive science experience outside the classroom. Students work in multi-aged groups on tasks sent to them by research groups'. The implementation research team consists of twenty-six teachers and school district personnel, educators from community-based science organizations, community college, and the university, as well as undergraduate and graduate students. This paper describes the first phase of project from the perspective of the project research team including the challenges we faced, the progress we made, our successes and what we learned about creating a science learning experience focused on understanding science as more than knowledge.

Dennis Sunal Cynthia Sunal Cheryl Mason Dean Zollman N. Rebello Glenda Ogletree Determining the Impact of Reformed Undergraduate Science Courses on Students: Implementation of a National Study P-115-207-206-243

Evaluating impact of undergraduate science courses and the extent to which they are standardsbased reform-oriented requires research knowledge and skills in several domains. The presentation outlines procedures in sampling from over 100 institutions, research design, selecting and developing instrumentation, gathering and analyzing data, and interpreting results. The elements are designed to investigate formative impact by 1) using critical variables from the learning environment, course structure, department culture, and college instructor and 2) outlining innovative procedures for gathering data during the course and summative impact by gathering short and long term data from students during the course and on special student populations of graduated students. Multiple quantitative and qualitative instruments are analyzed using comparative and relational studies at multiple points in this impact design model NSF Project. Conclusions drawn include evidence and effect sizes of short-term impact on all undergraduate students, long-term effects on graduated students in their workplace (e.g. in- service teachers in their own classrooms), and identification of characteristics of reform courses and instructors that produce significant impact. Data are used to develop criteria to identify differing levels of implementation of standards-based reform characteristics in courses that are important in the development of meaningful science learning outcomes in all college students.

Piyush SwamiTori LivingstonKarin (Carmen) MendozaHow Teachers Modify the Full Option Science System (FOSS) Curriculum in Urban and Suburban SchoolsP-43-88-87-124

This qualitative study builds upon the central role science teachers play in 'mediating between children's everyday world and the world of science' (Driver, Asoko, Leach, Mortimer & Scott, 1994, p. 11). The focus is upon modifications of a kit-based, inquiry science curriculum made by two teachers in contrastive contexts (urban and suburban). Both teachers fulfill criteria designating them as 'highly qualified' educators by the No Child Left Behind (NCLB) act, are experienced in teaching science and certified in Ohio. Both teachers used the third grade Water unit within the Full Option Science System (FOSS) curriculum to teach two distinctly different groups of students. The theoretical framework of the study is based upon how teacher thought process, as impacted by their respective teaching contexts, influenced their curricular modifications. Classroom observations, anecdotal field- notes, semi-structured audio-taped interviews and a teacher background questionnaire were used to collect data. Nine major curriculum modifications between the two teachers emerged from the research findings. These modifications were grouped into three categories: 1) FOSS- specific modifications made to the structure of the FOSS curriculum; 2) in-the-moment modifications made during the delivery of a lesson; and, 3) time-modifications made to the amount of time suggested for each lesson.

Chyrisse Tabone Barbara Spector

Students' reactions to controversial issues embedded in a college environmental science course P-492-1261-1260-1292

This qualitative study described non-science undergraduate majors' responses to controversial issues embedded in an introductory level environmental science class in a liberal art college. The class participants were both traditional and non-traditional age student. The structure of the environmental science course was consistent with the science education reform movement standards applied to K-12 public schools, but not yet pervasive in higher education. The central assumption underlying the study was controversial issues in science stimulates cognitive dissonance, which provides a pathway to higher level reflective thinking. The study showed the use of controversial issues in the environmental science course stimulated reflective thinking and promoted the expression of activism. Controversial issues triggering a response in students show elements of injustice and unfairness. Generational differences in students were observed in their openness to discuss controversial issues, ability to self-express, attitude toward the environment, and involvement in the educational process.

Tali Tal, Orly Morag

Action Research as a Means for Preparing to Teach Outdoors P-425-751-750-785

A major obstacle for employing outdoor learning is a consequence of insufficient preparation of the teachers for teaching in the outdoors. Although pre- and in-service teachers get many opportunities to learn in a variety of settings, they usually participate in these experiences only as learners. This experience is insufficient when the teachers are required to take their students out of the school, prepare and carry out a range of out-of-school learning experiences. Our own experience, which is in line with similar evidence of other studies, directed us as we used an action research project in an ecological garden aiming to find suitable ways to provide teachers with authentic experience of outdoor environmental education. Five pre- and in-service teachers participated in the action research study that included a thorough preparation, teaching of elementary and junior high school students in the ecological garden and reflecting upon this experience. The data that was collected by the teachers and the researchers indicated that the teachers faced several challenges, but the support provided, as well as their careful preparation yielded a positive experience to both teachers and students. Overall, action research could offer a framework for supporting teachers in outdoor teaching.

Vicente Talanquer

Teleological Explanations in Chemistry Teaching and Learning P-436-776-775-810

The present work represents an initial step at better characterizing the objects and occasions for instructional explanations in chemistry and the acceptable types of explanations in the discipline. In particular, in this study we focus our attention on the role and nature of teleological explanations and the conditions that seem to warrant their use in chemistry teaching. We also analyze the learning implications of developing explanations of chemical phenomena within a teleological stance. Our results are based on the qualitative analysis of the explanations presented in traditional chemistry textbooks. The analysis of the data indicates that teleological explanations are used sparsely and they are normally associated with a small but important group of chemistry topics. The occurrence of teleological explanations is tightly linked to the existence of a principle that governs the behavior of the system, and that explicitly or implicitly implies the minimization or maximization of a system's property (e. g. entropy, free energy). Teleological explanations seem to have pedagogical value in chemistry education: they help provide an explanatory reason for the occurrence of chemical processes; they allow the transformation of complex formulations into simpler ones, and they help students organize their knowledge around major ideas.

Valerie Talsma

Scientist as 'Self' and 'Other': Using self-schema theory as a heuristic for the DAST P-495-896-895-929

Classroom activities, media, literature and culture shape students' attitudes toward science and role of scientists in our society. Much of the research on images of scientist focuses on the stereotypes (white males), not on the similarities between drawing and drawer. This study examines sixth graders' and teacher candidates' images of scientists using not only the DAST checklist (Chambers, 1983) but also matches or similarities between subject and image in an application of self-schema theory to the draw a scientist task. The drawings by the teacher candidates contained more stereotypes and fewer matches to themselves than the drawings by the sixth grade students. The DAST and subsequent comparison activity was used in methods classes to heighten candidates awareness of stereotypes and to draw their attention to the types of classroom activities that invite children into the role of scientist (role playing, inquiry investigations, etc.). The goal is to help students and teachers construct a richer image of science that reflects the human component and connects science to their own abilities and values.

Edna Tan Sreyashi Basu Tara O'Neill Maria Rivera Maulucci Verneda Johnson

Sumi Hagiwara

Supporting Teachers in Fostering Youth Agency and Learning in Low Income Urban Communities S-553-1582-1581-1611

The focus of this symposium is to present a series of research studies focused on teacher practice and teacher learning in support of low-income urban student science engagement and agency. Research questions guiding this symposium include: 1. How do/can science teachers of minority students in urban schools help create meaningful school science experiences which draw from students' out-of-school funds of knowledge resulting in deep and consequential understanding? What are the specific science teacher practices that are effective in pursuit of this goal? 2. What are the tensions and constraints science teachers in urban schools face in supporting student agency and achievement? 3. What kinds of preparation and support do science teachers in urban schools require and how should they be provided? We will introduce over-arching questions and themes of the session and have individual contributors present their research. Then, there will be a whole group discussion of the over-arching questions and themes of the research, with an emphasis the research structure itself and its implications for science teaching and learning practices. Based on interest, participants in the session will join a group led by a presenter who will lead a discussion on themes particularly relevant to his/her paper

Roman TarabanAmy PietanRussell MyersAnalyzing Discourse Functions in Student Research Reports to Assess What Students Gain ThroughResearch ExperiencesP-371-1568-1567-1597

Two case studies are presented that concern scientific discourse and its relationship to students' communication about scientific practices. The goal was to develop an assessment tool able to track and evaluate the level and kinds of changes that result from students' participation in laboratory experiences. By looking at the frequency of specific discourse elements in research reports, we were able to describe and quantify the elements of students' lab experiences. Students' reports emphasized background facts related to their research projects and descriptions of the experimental procedures that were employed. The students showed essentially no evidence of developing scientific arguments. The findings indicate a need to provide more academic supports to students to develop critical thinking and explanatory skills that are necessary in lab research and the practice of science.

Amy TaylorMelissa JonesBethany BroadwellTom OppewalCoordinating Science Learning: Navigating Tensions between scientists and science educatorsP-154-504-503-540

Although there have been numerous studies that indicate the benefits of teachers and students working with scientists, there is little research that documents scientists' views of science education, science teacher preparation, and goals of science education. Through semi- structured interviews, the perceptions of 32 scientists from diverse science domains were explored. Results showed that 55% of the participating scientists perceived science education in schools today to be of poor quality due to various factors such as poor teacher preparation, students' lack of critical thinking skills, poor student problemsolving skills and limited application skills. Forty-one percent of participants stated that science teacher preparation should include more experiences for teachers to conduct science research and develop their own critical thinking skills. When asked what goals are most important for science education, 68% of participants stated that a good foundation of basic scientific principles and use of critical thinking skills should be priority. The need to coordinate the different perspectives of scientists and science educators for effective science education reform is discussed.

Joseph TaylorDoug CoulsonJanet PowellPam Van ScotterExamining the Relationship between Student Learning and Implementation FidelityP-612-1213-1212-1245

Is there a relationship between student learning and teacher fidelity of implementation of high quality curriculum materials? If there is a relationship, what is it and what are the factors that influence the relationship? Our study of these questions began in 1995 with a case study of four teachers who were field-testing a high school biology curriculum program. The preliminary study found differences in the pre-post learning gains of students whose teachers implemented the program as designed as opposed to those of students whose teachers implemented the program with considerably less fidelity. Because this study indicated a relationship between fidelity and student learning, we explored the relationship further with larger numbers of teachers and students. In 2002 we calculated the learning gains of 634 students field testing multi-disciplinary science materials and correlated them with implementation fidelity as measured with an observation protocol. The major finding of this study is the establishment of a strong relationship between student learning gains and implementation fidelity. Specifically the data suggest that the students of teachers implementing with a medium or high level of fidelity have significantly greater learning gains than the students of teachers who did not adhere closely to the program.

Megan Thomas

Impact of an Introductory College Inquiry Based Biology Laboratory on Biology Self-Efficacy P-153-1359-1358-1390

Self-efficacy theory was first introduced in a seminal article by Albert Bandura in 1977 entitled Selfefficacy: Toward a unifying theory of behavioral change. Since it's original introduction, self-efficacy has been a major focus of academic performance, anxiety, career development, and teacher retention research. Self- efficacy can be defined as the belief an individual possesses about their ability to perform a given task. Bandura proposed that self-efficacy should be measured at the highest level of specificity due to the fact that different people are efficacious in different areas. Interested in students' efficacy toward biology, Baldwin, Ebert-May & Burns (1999) created and validated a survey to measure students' biology selfefficacy. Their survey was modeled after the guidelines for science literacy, and loaded to three subfactors; methods of biology, generalization to other science courses, and application of the concepts. The current research investigated what changes in biology self-efficacy occurred after an introductory biology course with an inquiry based laboratory learning environment. In addition, we investigated the impact students biology self- efficacy would have on their overall course performance.

Julie Thomas Ratna Narayan

One-to-One Clinical Field Experience: Enhancing Science Confidence and Content Knowledge in Elementary Pre service Teachers P-388-684-683-718

This case study considers a unique, one-to-one field experience model as opportunity for increasing preservice elementary teachers' science content knowledge and science teaching confidence. Preservice teachers paired four preliminary interviews and supporting lessons that were individualized to match the conceptual learning needs of each student (from Kindergarten and grades 4-5) and to support standardsbased, science learning. Primary research data included interview transcripts, lesson plans, and reflection papers for both interview-teach sessions. Other complementary data included a science autobiography, preand post-course science-teaching metaphors, exam responses, and focus group interviews. Participating preservice teachers reported increased content knowledge, enhanced confidence, and new-found enthusiasm for science and science teaching. These results align with Bandura's (1977) theory of self- efficacy where the one-to-one clinical field experiences provided important mastery experiences. Preservice teachers, though initially anxious and fearful of these interviews and lessons, were particularly influenced by the positive responses and comments of the elementary students. Perhaps there are implications here about how and when elementary preservice teachers can or should learn the science content knowledge they will need as elementary teachers. Perhaps, too, there are implications about how to focus field experience lessons so that classroom management concerns do not diminish these early teaching experiences.

Sheraton New Orleans Hotel • New Orleans, LA

Jessica Thompson

Mark Windschitl

How underserved urban girls engage in co-authoring life stories and scientific stories P-255-595-594-631

Contemporary critics of science education have noted that girls often fail to engage in learning because they cannot see themselves in science. Yet theory on identity, engagement, and the appropriation of scientific discourse remains underdeveloped. Using identity as a lens, we constructed two two-week lunchtime science sessions for seventeen, ethnic minority high school young women who were failing their science classes. The units of instruction were informed by a pilot study and interviews with the young women from the previous year. Data sources included: videotaped lunchtime sessions, individual interviews (over the course of 3-4 years), small group interviews, student work, observations of science classes, teacher surveys, and school records. We used a case study approach with narrative and discourse analysis. Not only were the young women individually involved in negotiating ideas about who they are and who they are becoming, but collectively the group created a space where they productively negotiated multiple identities to appropriate scientific ideas.

Norman ThomsonPanwilai ChomchidSutthida ChamratLearning Atomic Structure and the Periodic Table Using 3D Hands-on VAST-Models and Video AnimationsP-233-433-432-469

Visualization is essential for learning and understanding chemistry and is especially important for developing foundational knowledge of atomic structure and the periodic table. Teachers and students share difficulties in developing a meaningful dialogue for understanding both and it is well documented that it is a challenging problem globally. We have developed hands-on 3D VAST-Models and used selected video animations to enhance secondary school teachers and students inquiry into the development and use of models throughout the history of chemistry. Our data was, in part, collected as digital video and is being analyzed using the innovative Video Analysis Tool (VAT) and the Evidence Based Decision Support (EBDS) framework. Students prefer dynamic hands-on 3D models because it allows for active inquiry, exchange of ideas, and comparative critique for the use of models in representing atomic structure and periodicity. Pseudo-3D video animations allow for further development and understanding the history and context of understanding atomic theory. Our paper provides insight into what we have learned, and the experiences of teachers and students, in using VAST-Models and video animations for teaching and learning in high school chemistry in a historical context.

John Tillotson Monica Young Robert Yager John Penick Julie Luft Danielle Ford

Teacher Professional Continuum Research: Cross-Project Comparisons of Practical, Theoretical and Methodological Considerations in Conducting Large-Scale Teacher Education Research Studies S-479-1510-1509-1540

This special symposium will highlight the broad range of theoretical, practical and methodological issues that must be addressed by investigators when conducting large-scale teacher education research projects such as those supported by the National Science Foundation's Teacher Professional Continuum (TPC) program. Researchers affiliated with three current TPC projects will share information on how they have successfully managed these challenges relative to their own studies and share examples of the lessons learned throughout the process. In particular, the symposium panelists will discuss the need for careful planning and ongoing monitoring of research procedures, as well as the consistent and rigorous implementation of those procedures across multiple sites within longitudinal studies. Discussion will also take place concerning the attrition of research subjects, the transition of project staff, the need for data management systems, changing availability of data sources, changing contexts caused by policy and instructional decisions at the federal, state or local levels, anticipated data analysis schemes, establishing connections to supplemental research data sets, and consideration of the audience to whom the research outcomes will likely have the greatest appeal. The symposium panelist will share examples of their data collection instruments, analysis schemes and preliminary findings as illustrations.

Briana TimmermanRobert JohnsonJohn PayneDevelopment of a 'universal' rubric for assessing students' science inquiry skillsQ-159-1427-1426-1458

We report on the development and testing of a universal rubric for lab reports designed to measure student ability to engage in authentic scientific inquiry. The rubric's reliability was tested using three different assignments from three different higher-education biology courses (45-50 unique student papers per assignment, total reports n=142) with three unique raters per assignment (total = nine raters). We provided a five-hour training session to the science graduate students comprising the scoring team prior to initiation of formal scoring. Additionally, a parallel but non-overlapping set of untrained science graduate students (n=8 raters) evaluated the same papers using the same set of criteria. Generalizability analysis indicates that the rubric is a reliable metric (inter-rater reliability 0.85 for each of three groups of trained raters). Further, comparison between the trained scorers using the rubric and the natural, untrained grading condition provide a baseline reliability of science graduate students for evaluating student work. Lastly, application of the rubric to portfolios of student work over multiple courses provided both a measure of student achievement as well as curriculum effectiveness. We therefore encourage the use of the rubric at multiple levels: 1) assessment of student abilities within a course; 2) student achievement over time/ multiple courses; 3) evaluation of curricula.

Kenneth Tobin

Plenary address: Toward a brighter future for science education: Cogenerating success through participatory inquiry P-785-1695-1692-1722

It is a challenge to embrace a premise that all participants in research in science education will benefit from studies in which they participate. No longer can researchers discover gaps and inequities without acting to resolve them as they are identified and understood. As our research program evolved over 30 plus years, we adopted authenticity criteria by which all participants in research: change their ontologies; are educated about the perspectives of others; experience positive changes catalyzed by the research; and, when inequities are identified, we help those who are disadvantaged to succeed. We employed cogenerative dialogues to involve K-12 students, teachers, teacher educators, and administrators in collaborative research with university based researchers. Accordingly, we listen to the voices of participants and encourage them to shape and focus the research and its findings. Even in the most challenging of schools we see pervasive examples of science curricula being transformed to allow for student success. Teachers and students create new roles, engage to promote science literacy, and improve the quality of social life out of school. Students categorized as at risk of dropping out of school not only learn to succeed at school, but expand their visions of the possibilities of schooling, employment, and further education. I use theory, methodology and empirical analyses to highlight the role of emotions in teaching and learning science in culturally adaptive ways and illustrate how science teachers and students overcome cultural problems associated with immigration, ethnicity, poverty, and being racialized and gendered.

Lana Tockus-Rappoport Guy Ashkenazi

Connecting Levels of Representation: Emergent vs. Submergent Thinking P-695-1423-1422-1454

Chemical concepts can be represented on three levels: macroscopic (phenomena level), microscopic (particle level) and symbolic. Chemists think of substance properties on the macroscopic level as emerging from mechanistic interactions between particles on the microscopic level. Through interviews of faculty members, graduate and undergraduate students, we have shown that students' understanding of the relation between these levels often deviates from that of the faculty members. One deviation is the consideration of only a single representation level - either the macroscopic or symbolic. The other deviation is thinking about the macroscopic properties as the reason for particle behavior, rather than the other way around. Students often use their familiarity with a symbolic equation relating macroscopic properties (such as the ideal gas equation) as the starting point of a thought process which leads them to impose mechanistically unwarrantable behavior upon the particles. Being the reverse of the 'emergent phenomena' thought process, we designated this as a 'submergent' thought process. Such thought processes allow students to avoid confronting their misconceptions about particle behavior, but posing a demand for a mechanistic explanation undermines their confidence in such reasoning. It is suggested that the directionality of connecting particle behavior to macroscopic properties should be emphasized in teaching.

Regina Toolin Sandra Flank

A Tale of Two City Schools: Supporting project-based inquiry in secondary science education *P-666-1364-1363-1395*

This study examines the factors that influence the successful implementation of project-based inquiry in suburban and inner-city secondary schools. The researchers assumed the role of participant observers as they mentored, co-developed and researched the development and implementation of project-based inquiry at these schools. Data was collected through mixed methods including student achievement data, classroom observation notes, anecdotal notes, project/lesson plans, and student investigative journals and projects. Many factors influenced the infusion of project-based inquiry into these schools including prior knowledge and experience of project-based inquiry; influence of school vision, mission and philosophy; resource availability and ongoing one-on-one professional development.

Mustafa Topcu

The Development of Metacognitive Skills among Elementary School Students: A Cross-Sectional Study P-298-1050-1049-1083

The purpose of this cross-sectional study was to investigate the effect of grade level on elementary school students' metacognitive skills. The Junior Metacognitive Awareness Inventories (Jr. MAI) (Version A for grade 4 and 5; Version B for grade 6 through 8) were administered to 315 students enrolled in grade 4 and grade 5 and 626 students enrolled in grade 6 through grade 8 of seven elementary schools located in urban and rural regions of Ankara, Turkey. Exploratory factor analysis revealed two factors knowledge of cognition, and regulation of cognition- for the grade 4 and grade 5, and grade 6 through grade 8 students. For knowledge of cognition MANOVA analysis revealed significant differences between grade 4 and grade 5 students. For regulation of cognition MANOVA analysis revealed significant difference among grade 6, 7, and 8 students. For regulation of cognition MANOVA analysis revealed significant differences between grade 4 and grade 5 students favoring grade 5 students and could not be found any significant difference among grade 6, 7, and 8 students. For regulation of cognition MANOVA analysis revealed significant differences between grade 4 and grade 5 students favoring grade 5 students favoring grade 5 students and could not be found not any significant differences among grade 6, 7, and 8 students.

Eva Toth Felicia Cianciarulo Garth Ehrlich

Christopher Post

Supporting Conceptual Change Via Collaborative Inquiry Using Virtual Laboratories in an Introductory College Classroom Q-216-1434-1433-1465

In a prior NARST presentation, the authors presented the effect of various representational tools - such as pictures, tables and concept maps - to support experimentation in an inner city high school. The goal of the current study is to provide evidence for the use of representational tools to support collaborative inquiry in a college introductory science classroom. By employing a pre- and post-instruction and experimentation measures of individual and group learning, we examined student-trajectories of experimentation and learning. The results provide evidence for the formulation of classroom pedagogies that employ external representations and collaborative learning to teach science with on-line, virtual laboratories. The study focuses on issues of key importance to NARST members and the results are informative for educational researchers, as well as college classroom practitioners.

David Treagust Nookorn Pathommapas Chi-Yan Tsui

The Impact of a Series of Predict-Observe-Explain Tasks on Thai University Students' Understanding of Concepts in Electrochemistry P-273-1617-1616-1646

The aim of this study is to investigate the impact of a series of Predict-Observe-Explain tasks on students¹ understanding of concepts concerning Galvanic and electrolytic cells. The Predict-Observe-Explain tasks were part of the laboratory exercises, modified from Driver's constructivist teaching sequence, designed to help change students alternative conceptions in electrochemistry. The sample was 120 first year students of Udon Thani Rajabhat University. To ascertain students learning, a cross- section of data collection methods included two-tier multiple-choice diagnostic tests, concept mapping, written work and interviews. Additionally, the Constructivist Learning Environment Survey (CLES) was used to examine the climate of the classrooms that used the Predict-Observe- Explain tasks. The research showed that students who had alternative conceptions in electrochemistry could be convinced to change their views after the Predict-Observe- Explain tasks in the laboratory. The different data collection methods enabled triangulation to validate students understandings on both pre and post-instruction. The results of the CLES Dascales pointed that the teaching and learning environment had a high degree of satisfaction.

Georg TrendelHans FischerRainer WackermannThomas ReyerVideo-based in-service training to improve science teachers' support of learning processesP-140-755-754-789

Recent large-scale assessments like PISA and TIMSS have drawn attention to the fact that in German schools learning outcomes in science education are not as good as expected. One major deficit in instruction is seen in the lack of support for specific learning processes that are relevant to achieve a deep understanding of science concepts and processes. The aims of our study are twofold: It was intend to investigate conditions for successful learning processes in detail and to describe possibilities to enhance teachers' understanding and support of such processes by means of a dedicated in-service training. To foster physics teachers focusing on learning processes theory-based conceptions of learning processes and tools to investigate those learning processes are described and applied to in- service teacher training. Category-based video-analyses of actual lessons are proposed as important and powerful instruments for research as well as for teachers to reflect their own lessons. Results of the investigation indicate that theoretical models and tools indeed possess a potential to enhance support of learning processes by teachers and thus to facilitate students learning of physics skills and concepts.

Thomas Tretter Gail Jones Michael Falvo

Nanoscience Course Impact on Conceptions of Spatial Scale P-478-966-965-999

The field of nanoscience is growing quickly, and there is interest in bringing aspects of this emerging field to science classrooms grades 7-16. Because the scale of the phenomena is central to the potential and excitement of nanoscience, student conceptions of scale are a critical piece for introducing this field to students. This study investigated a semester-long nanoscience course for college freshmen to identify how participants' conceptions of nanoscale were impacted by the course. Results showed a heightened conception of scale distinctions at the nanoscale, enhanced accuracy at that scale, and improved understandings of the significance of nanoscale science. Discussion of how this course accomplished this along with possibilities for applying the findings to other educational settings is included.

Thomas TretterSherri BrownWilliam BushJon SaderholmBeverly MooreValid and Reliable Physical, Life, and Earth Science Content Assessments for Middle School TeachersQ-478-967-966-1000

Depth and breadth of science teachers' content knowledge is an important influence on student learning. This paper describes the process of constructing valid and reliable physical, life, and earth science assessments to measure breadth and depth of middle school teachers' content knowledge. Content validity was strengthened through analysis of content recommendations in national standards documents, analysis of the research literature, and extensive use of item-writing teams. Construct validity was supported by using science teachers, scientists, and science teacher educators to evaluate each assessment item regarding the type of knowledge and content category. Assessment field testing provided measures of internal reliability, equivalent forms reliability, and inter-rater reliability for the open-response items. Assessment construction process and results are detailed.

Kathy Trundle Randy Bell

A Comparison of Three Instructional Interventions Designed to Promote Conceptual Change P-182-296-295-332

This study describes preservice elementary teachers' conceptions of moon shapes and the cause of moon phases before and after inquiry-based instruction. Two of the three instructional interventions integrated planetarium software, Starry Night, with inquiry-based instruction on moon phases. The study compared three different treatments: instruction in which 1) students used a computer simulation exclusively for data gathering (n = 50); 2) students collected observations from both the computer simulation and from nature (n = 61); and 3) students collected data solely from observations of the natural phenomenon (n = 46). Data sources included drawings, interviews, and a lunar shapes card sort. Videotapes of participants' interviews were used along with the drawings and card sorting responses during data analysis. The various data were analyzed via a constant comparative method in order to produce profiles of each participant's pre- and post-instruction conceptual understandings of moon phases. Pre- to post-instruction gains were substantial for all three treatments and for all targeted concepts. However, participants using Starry Night exclusively made substantially greater gains than those who gathered observations from Starry Night with nature or from nature alone. Results demonstrate that a well-designed computer simulation can be effective in eliciting desired conceptual change.

Blakely Tsurusaki Charles Anderson

Students understanding of connections between human engineered and natural environmental systems: Similarities and differences across grade level and context P-529-970-969-1003

This research, which is part of a larger environmental science literacy project, draws on developments in educational research where learning progressions are emerging as a strategy for synthesizing research on science learning and applying that research to policy and practice, and advances in the natural sciences, where interdisciplinary research on coupled human and natural systems has become increasingly important. It focuses on the human systems that supply all of our essential goods and services (i.e., food, water, transportation), which begin and end in the earth's natural systems. In order to investigate what students know about how human actions affect environmental systems, we developed assessments focusing on supply and waste disposal chains. In addition, students were asked about two major environmental issues global warming and preserving our forests. Assessments were administered to elementary, middle, and high school students from rural, suburban, and urban schools. Results from this study provide insight into how student knowledge of connections between human- engineered and natural systems varies across grade level and context, which is essential if we are to teach students to be responsible citizens and stewards of our environment.

Hsiao-Lin Tuan Chi-Hung Liao Hung-Chih Yen

Comparing the effect of motivation between web-based instruction with traditional science teaching on students' conceptual learning outcome

Q-408-1451-1450-1482

The purposes of this study were to compare the effect of Dual Situation Learning Model (DSLM) (She, 2002, 2003) web- based instruction context (WBC) with traditional science teaching context (TSC) on students' conceptual change learning outcome, and to explore the effect of students' intrinsic and situated motivation on their conceptual change. Seven classes, 147 8th graders were involved. Five classes involved in WBC, two classes involved in TSC. In WBC, chemical reaction lessons are divided into eight main sections to reflect on students' misconceptions. Students' intrinsic as well as situated motivation has been collected in the beginning and during instruction. Students' learning outcome were assessed by two-tier test pre and post conceptions and situated challenge tests. ANCOVA and path analysis were used for data analysis. Findings revealed students' conceptual change in TSC, but not in WBC. Students' situated motivation (students' motivation during instruction) showed more significant effect on the amount of conceptual change than their initial motivation in WBC group. Implication of the study would be discussed in the paper. Keywords: conceptual change learning, learning motivation

Steven Tuckey Brett Merritt Dipendra Subedi

WebPlans: A Web-based approach to technology integration in science teacher education P-688-1387-1386-1418

The successful integration of technology in teacher education can deepen pre-service teachers' understanding of pedagogy and expand the contexts in which it can be practiced, while also increasing their fluency with potentially valuable teaching tools. In this paper, we suggest one framework for technology integration, WebPlans, and we share our experiences with integrating it into pre- service science teacher education courses. Our three main claims about WebPlans in this paper center on their role in improving pre-service teacher communication with multiple communities, increasing pre-service teachers' technological fluency, and the adoption of WebPlans as an organized and interconnected instructional model. Each of these claims rests on data collected over the course of three years, spanning two distinct groups of pre-service science teachers.

Carrie Tzou Heather Zimmerman Philip Bell

Bringing students activity structures into the classroom: Curriculum design implications from an ethnographic study of fifth graders images of science *P*-536-1486-1485-1516

This paper asks the question: How can we apply what we know about students' everyday scientific sensemaking practices to the design of an in- school science and health curriculum? This study is part of an ethnographic study in which we follow 13 children in school and into their homes and communities. We use an everyday expertise framework to analyze these students' scientific sense-making activity systems from individual, social, and cultural planes (see paper 1, this set). We look for instances in the ethnographic data in which students either choose to participate in scientific activities or clearly disengage from activities that could be scientific. We ask what images of science might be in play in their decisions to engage (or not), and how we can build from these activity systems into the design of formal instruction. Specifically, we are studying what personal epistemologies emerge for students during these activities, what images of science are available to students in cultural artifacts, and how we can connect students' personal epistemologies to the scientific practices in the design of a classroom curriculum. This paper discusses two case studies from the data and design implications that emerge these cases.

Sedat UcarKathy TrundleLawrence KrissekThe impact of inquiry-based and technology supported instruction on pre-service teachersconceptions oftidesP. 62.041.040.074

P-63-941-940-974

The purpose of this two-phase sequential mixed method study was to understand and describe preservice teachers' conceptual understanding of tides before and after technology-enhanced, inquirybased instruction, and to explore instructional strategies that promote the learning of scientific concepts. Participants (n=80) were pre-service teachers in three initial licensure programs at a major Midwestern research university. All 80 participants took the pretest and 19 of the 80 completed the instruction. These 19 participants took both pretest and posttest and were interviewed before and after the instruction. An independent t-test on pretest total scores indicated that the instruction group (n=19) was not statistically different from other students (n=61) in the programs. Qualitative analysis of interview data indicated that 30 participants (instruction group plus 11 others) had alternative conceptions, especially a one bulge model of tides, before instruction. After instruction, participants' conceptions of tides changed significantly and became more scientific. Multiple regression analyses revealed that three test items which measured the correlation between moon phases and tides, the gravitational pull of the moon, and the presence of two tidal bulges on opposite sides of the earth, were the best predictors of the gain score. Implications will be presented.

Bhaskar Upadhyay

Cristina DeFranco

Elementary Students Retention of Environmental Science Knowledge: Connected Science Instruction Versus Direct Instruction P-179-1410-1409-1441

This study compares third grade elementary students' gain and retention of science knowledge over time in two different classes connected science instruction vs direct instruction. Data analysis yielded that students who received connected science instruction showed less gain in science knowledge, in the short term, compared to students who received direct instruction. On the other hand the growth curve demonstrated lower rate of loss of science knowledge among students in connected science classes compared to students in direct instruction classes.

Sibel Uysal Gita Perkins

The Dynamics of Different Group Composition on Interdisciplinary Lesson Development During a Summer Workshop

P-308-536-535-572

Abstract A series of Communication in Science Project (CISIP) professional development workshops provided an opportunity for the formation of TLCs (Teacher Learning Communities). This is a partnership of Science, English, and ESL teachers, community college faculties with an ASU professor and her graduate students. This community provides opportunities for teachers to network and share classroom expertise in a structured setting and to design their own CISIP lessons based on the CISIP model. The teachers came together over time to explore academic language acquisition and oral and written discourse in the science classroom. Our objective was to determine the effectiveness of the group compositions and the group interaction when teachers developed their CISIP lessons during the 2006 CISIP summer workshop. During the workshop, six different structures of groups were observed and videotaped to determine ideal group composition when designing CISIP lessons. Middle groups and teachers coming from the same school built successful teams to our four observation criteria. ELL teachers were the least effective members of the group because of their science background and the application of inquiry to the lessons.

Nicos Valanides Charoula Angeli

A Framework of Electronic Mentoring Prompts for Promoting Learners Scientific Reasoning Skills in a Text-based Online Conference for Science Education P-239-771-770-805

The purpose of the study was to develop an instructional framework for promoting learners' scientific reasoning skills in a text-based online conferencing system for science, and then to report on its effectiveness. A review of the literature was conducted and the results of the review identified three different types of written prompts for promoting reasoning skills in science. They included (a) prompts for promoting conceptual understanding in science, (b) prompts for promoting general thinking skills, and (c) prompts for promoting science-specific processes. The results of the study showed that the framework of electronic mentoring prompts was beneficial for the development of learners' scientific reasoning skills, provided that the instructor properly and persistently mediates students' online discourse.

Glenn Vallender

Standards-Based Assessment of Geology and Evolution in the New Zealand Secondary School Curriculum. P-552-1036-1035-1069

This paper focuses on aspects of assessment in the relatively unexplored domain of Earth Science education. The New Zealand curriculum has undergone significant change over the last decade in moving from a norm-referenced ranking system of national external examinations based on a history of British colonialism, to one of standards based or criterion-referenced internal and external national examinations. There are complex historical curriculum development issues in subject overlaps such as those between geography and geology and biology and paleontology. Aspects of current standards based assessment objectives are discussed in relation to three key issues of Earth Science education the fossil record, geological time and evolution. Achievement standards and unit standards are described. Other important aspects of assessment in Earth Science such as geological structures, landform evolution, and natural hazards are not addressed in this paper. Aspects of the status of Earth Science within the New Zealand Science curriculum are briefly discussed. Biology standards provide the greatest opportunity for learning about biological evolution but this opportunity is limited until the final year of secondary school. The structure of relevant standards based assessment tasks is described.

Michiel van Eijck

Wolff-Michael Roth

The development of scientific literacy by using information technology-based research tools Q-682-1377-1376-1408

Considering the aim of scientific literacy, the role of IT-based research tools in science curricula is dissatisfying. This is due to its definition in terms of skills and procedures, which stems from a perspective with technology rather than education in mind. To appropriately frame the role of IT-based research tools in science curricula, we propose a framework for understanding the use of tools in human activity, namely cultural-historical activity theory (CHAT). Accordingly, we rethink the role of IT-based research tools in science curricula. IT-based research tools, as any tools, are understood as constituting human activity, and, hence, cannot be seen apart from both its objectives and the cultural-historical determined form of activity (praxis) in which subjects participate. Based on empirical data from students and researchers participating in research, we point out how an appropriate account of IT-based research tools involves subjects' use of tools with respect to (a) the objectives of research, and (b) the contribution to research praxis. We reconceptualize the role of IT-based research tools as contributing to scientific literacy if students participate in research, that is, if (a) they collectively modify these tools with respect to the research objectives, and (b) therewith contribute to research praxis.

Meta Van SickleCarol TempelGeorge TempelChange in the Practices of Scientists as They Work in Public School ClassroomsP-504-1343-1342-1374

Change in the Practices of Scientists as They Work in Public School Classrooms Survey data of belief changes assessed with CLES, and STEBI instruments is presented for three years of NSF funded GK12 fellows and teachers. The Medical University of South Carolina (MUSC) and the College of Charleston (COFC) are participating in a NSF funded GK12 project. We have been monitoring the beliefs of the scientist fellows since the inception of the program. The literature is clear about the difficulty and lack of likelihood that beliefs will change over time. CLES, and STEBI instruments were used to review the scientist changes over three years. The instruments were administered prior to entrance and at intervals to test impact based on hours of professional development. Findings showed significant changes after 135 hours in the program.

Binaben Vanmali Sandra Abell

Perceptions of College Science Tutors about their Roles P-457-815-814-849

College students struggle to learn science, especially at larger universities, where access to faculty is limited. Students look beyond the classroom for other avenues by which to master the course content, often seeking the help of science tutors to learn science. Therefore, it is important that we gain a better understanding of what science tutors do and why they are effective. In this study, we used interviews of college science tutors to learn about what they believe the role of tutor entails and what qualities are fundamental to tutoring. Using observations and document analysis as supporting data, we identified themes that tutors believed were integral to their roles, including: specific skills and abilities, effective tasks and strategies, methods of assessing needs and understandings, descriptions of their view of the role of tutor, and the benefits they gained from tutoring. Tutors felt that without these, their ability to help students was limited. These findings have implications for identifying and developing methods to help college tutors to be effective teachers of science.

Maria Varelas Christine Pappas Justine Kane

Eli Tucker-Raymond

Drama Activities as Ideational Resources P-507-922-921-955

This study explores urban primary-grade children's ways of developing and communicating scientific understandings through their engagement in drama activities, which were part of two integrated science-literacy units, Matter and Forest. Using a qualitative, interpretive method, three functions of dramatic enactments are studied: ideational, interpersonal, and textual. More than as just an object or a symbol, children used their bodies to actively construct what it meant to be a molecule in a liquid or a chipmunk in a food web. As the children had to decide how they would move as molecules in a solid, or how they would be connected with other animals and plants in a food web in a forest community, they debated, reasoned using ideas they had read about, questioned, and made sense of important ideas of the instructional units. These meanings were not generated in individual children's minds. They were collaboratively and interactionally constructed among the members of these classes among the children themselves and between the teacher and children. The study shows how drama activities are a unique kind of semiotic tool where meaning is expressed and developed simultaneously in visual- spatial-kinesthetic ways as well as linguistically.

Rainer WackermannHans FischerGeorg TrendelEvaluating the effectiveness of a learning-process oriented training of physics teachersP-444-793-792-827

We developed and conducted a learning-process oriented training of physics teachers and evaluated its effects at various levels including effects on students. Sample size is n = 2x18 in-service physics teachers in a quasi-experimental pre-post-design with control group. Theoretical background of the training is the theory of basis models of teaching and learning by Oser & Baeriswyl (2001). Learning-process orientation is thus operationalized as basis model orientation. A reliable and valid training-specific video analysis tool was then developed and used to investigate classroom actions of teachers and students. Questionnaires asked for aspects of teachers' and students' cognitions as pre-and post-measurement. Findings show that 90.4% of all videotaped lessons (86 videos, n = 3973 min) can be categorized according to the categories of our video analysis tool. Over the course of the training both teachers' and students' actions in the classroom effectively improve. Also, students' perceived clarity of instruction effectively improves. Further analyses compare additional teacher and student variables between pre- and post-measurement to the control group. Linked with information from the videos this can reveal aspects of teaching that can effectively help students to better follow physics instruction. Methodology, design and results of the study are reported.

Nader Wahbeh Fouad Abd-El-Khalick

Modes of Discourse in Science Classrooms: The Failure of Static Models in Capturing Complex Classroom Dynamics

P-313-537-536-573

This study aimed to examine the meanings that students construct in science classrooms as a result of the prevalent mode of discourse by conducting an exploratory ethnographic study of the social interactions and classroom discourse in three middle school science classrooms taught by the same teacher. The classrooms were observed over the course of two months and classroom interactions were selectively transcribed for analysis. The teacher and her students participated in individual interviews. Analyses indicated that the participant teacher consciously used different modes of discourse, triadic or dialogic, in different classrooms as a result of the fit between classroom milieu and her emic perspective of a good science classroom. Also, student images of nature of science were not related to the mode of classroom interaction.

Bruce WaldripPaula ReneeDarrell FisherJeffrey DormanUsing measures to teacher interpersonal behaviour to bring about change in primary science classroomsP-53-105-104-141

The paper reports on part of a large-scale study aimed at examining students' perceptions of teacherstudent interactions. This paper will report on a case study utilising mixed methodology in 12 Queensland primary classrooms. After the students' perceptions were established, the teachers, through a consultative process, developed strategies to change the students' perceptions of their classroom over a three month period. The paper reports on what strategies these teachers utilised and what changes in students' perceptions resulted. The classroom teachers were interviewed about the change in students' perceptions, what changes they had sought to promote in their classrooms, and what they felt had been achieved in their classrooms. The study found that students were able to articulate what changes the teacher had implemented, what their reaction was to these changes and their perception of the classroom environment as a result of these implemented strategies.

Bruce WaldripDarrell FisherJeffrey DormanPerry den BrokTypology of interpersonal education for primary educationQ-53-104-103-140

This study reports on the first development in Australia of primary science teacher typologies of teacherstudent interpersonal behaviour. Teacher-student interpersonal behaviour was measured by students' perceptions using the Questionnaire on Teacher Interaction (QTI). Earlier work with the QTI in The Netherlands has revealed eight different interpersonal styles. These eight styles were later confirmed in an American sample of secondary school teachers and similar types were found in a sample of Australian secondary school science teachers. The present study investigates the extent to which typologies found in earlier studies also apply to primary teachers. A cluster analysis using various clustering methods and procedures was used to determine Australian typologies and compare these with earlier findings. Results of the cluster analyses were verified by analyses of variance, by plotting QTI scale scores graphically and by presenting a set of sector graphics to two independent researchers and having them sort these into different profiles as found in the statistical analyses. The resultant typologies are presented in this paper. Also, implications for professional development and research are discussed.

Tamara Wallace Brenda Brand

Sociocultural Awareness: A Precursor to Culturally Responsive Practices P-737-1552-1551-1581

Factors contributing to the instructional practices of culturally responsive teachers were the focus of this qualitative research study. This case study involved two middle school science teachers deemed culturally responsive because they consistently achieved academic success with minority students' from disadvantaged backgrounds. Critical race theory was used to explore the philosophies, beliefs and practices of these teachers in order to determine the influence of race on their consciousness. This focus was significant in addressing current trends in multicultural and diversity education which deemphasize the notion of race and encourage greater emphasis on cultural expressions and differences. Findings indicate that teachers' instructional practices were motivated by their understanding of the sociocultural influences of race on their students' presence in the classroom.

Robert Wallace

Professional Development in Schools and its Impact on School Policy P-356-847-846-881

The Math, Science and Technology Enhancement Project (MSTEP), a professional development program implemented by the Department of Teaching and Learning at New York University and operated in partnership with public schools in New York City, has eight years of success in improving math and science teachers. A unique component of MSTEP is the support provided by an urban master teacher, a full- time member on the NYU faculty, who works in the classroom with the teachers who are part of MSTEP. MSTEP has expanded in the last two years to include a partnership relationship between NYU and some struggling secondary schools. In a school partnership, the urban master teacher works with all of the math and science teachers in the school regardless whether the teacher is a student at NYU. This partnership has led to some documented success in the development of teacher learning communities as well as in improved test scores for math and science students. However, we have also learned that a successful partnership is dependent upon administrative support in the school as well as on the overall culture of collaboration that may or may not exist in the school or academic discipline.

Chia-Yu Wang Mark Volkmann

Dynamic Model of Pedagogical Content Knowledge P-758-1629-1626-1656

Teaching is a messy business. Upon entering a student-centered activity-based high school biology class, a novice might see pandemonium where an expert sees productivity (Bransford, 2003). Obviously, the novice and the expert experience this classroom in very different ways. What they see is influenced by what they know. But, understanding the explicit knowledge of what makes these views different has been a difficult puzzle to solve. In an effort to refine our thinking, Shulman (1986) provided an explicit categorical model that helped focus attention on a few key characteristics of teaching that he called pedagogical content knowledge (PCK). The model he proposed distinguishes teachers from subject-matter specialists, based on their specialized knowledge for teaching. However, his model provides a static picture of teacher knowledge. It gives no hint as to what knowledge a teacher should possess. As teacher educators, our job is to prepare science teachers. We need a model that not only clarifies categories of teaching knowledge, but we need a clear picture of what it means to have high quality PCK. This paper presents a dynamic model of PCK.

William WatsonCurtis PykeSharon LynchUnderstanding the Effectiveness of Curriculum Materials through ReplicationP-265-1360-1359-1391

Replication of quasi-experiments in science education is important to establishing a convincing empirical basis for understanding the effects of interventions. However, a traditional view limits replication to studies by different researchers at different sites and different times. In this paper, methods and results from three quasi- experiments (N = 2,170, 2,252, and 1,761, respectively) on one middle school motion and forces unit in one large, diverse school district are presented to suggest a broader understanding of replication as refinement of research design. Effect sizes were small in quasi-experiments 1 (F, 1, 2169 = 6.44, p < .05, Cohen's d = .10) and 2 (F, 1, 2251 = 2.546, p = .11, Cohen's d = .06). Disaggregated data revealed larger differences between the highest and lowest performing subgroups of students when the intervention was used. However, attention to potential threats to validity revealed in conducting the research allowed for the collection of more valid data in quasi- experiment 3. When additional variables were controlled, results indicated an advantage for all but two subgroups when the intervention was used (F, 1, 1760 = 24.49, p < .01, Cohen's d = .23). Implications for replication, collaboration in conducting quasi-experiments, and scale- up are discussed.

Bryan Wee

An international comparison of children's drawings: Conceptions of the environment in Singapore and the U.S. P-455-817-816-851

The purpose of this study is to explore children's conceptions of the environment using a multicultural lens. Children's conceptions differ based on unique socio- cultural-political experiences, and understanding how children's ideas develop in an increasingly global society is an important step toward creating an informative and inclusive curriculum for environmental education. This paper presents and compares data obtained from a sample of ninth-graders in Singapore and sixth-graders in the U.S. Children were asked to complete a draw-and-explain task designed to elicit their conceptions of the environment. Their drawings and written responses were analyzed inductively using a qualitative research design. Data were coded and grouped into categories to identify patterns in the data and to generate assertions. The findings indicate that children in Singapore are more likely to include human interventions in their conceptions of the environment whereas children in the U.S. tend to associate the environment with natural areas. Regardless of nationality, however, the children in this study appear to frame their conceptions within an anthropocentric worldview.

Molly Weinburgh

Sustained Professional Development: An Examination of the Effects on Urban Elementary Teachers Content and Practice P-29-530-529-566

Eighteen elementary teachers participated in a year-long professional development program focusing on water issues. Using the local theme of water issues' and restricting the participants to only two elementary school allowed us to create a personal relationship with the teachers while addressing a local and contextualized need. This study examined the following questions: (1) Did the participating teachers enhance their content knowledge about ecological problems related to water quality and management?, (2) Did the participating teachers increase the implementation of inquiry-based teaching in science?, and (3) Did the participating teachers increase their use of reflective practices? Data were collected and analyzed using both quantitative and qualitative methods. To assess objective 1, a 10-item short-answer paper-pencil test was administered on three occasions. A one-way repeated- measures ANOVA was conducted on the pre-program, post- program, and follow-up scores for the 18 teachers who took the tests on all 3 occasions. The analysis revealed a significant difference in scores F (2, 16) = 42.25, p <.001. To assess objectives 2 and 3, classroom observations were conducted throughout the year. The analysis indicated an increase in inquiry teaching and in reflective practices.

Ayelet Weizman David Fortus

The Driving Question Board: A Tool to Support Inquiry-Based Learning P-268-613-612-649

Inquiry learning is often a challenge to students and teachers. We describe an instructional tool called a Driving Question Board (DQB) that can support inquiry- based learning and instruction. In this study we investigate the use of a DQB by teachers piloting a 6th grade project- based unit on light, evaluating how the DQB used by teachers and students and how the DQB affect students' learning. Findings indicate that students felt the DQB helped organize their thinking and gave them a sense of purpose.

Ayelet Weizman David Fortus

Using Scientific Models to Learn about Shadows P-442-1008-1007-1041

The purpose of this study is to investigate how scientific modeling can support middle school students in learning about shadows. The context for this approach is a 6th grade unit about Light, which is part of a new science curriculum for middle school students. In the pilot of this curriculum about 180 students constructed a model of how we see and applied it to the phenomenon of shadows. We found that using this model improved students' understanding of the nature of shadows, the connection of a shadow to the light source, and the parameters influencing its size. Nevertheless, students could not connect the shadow to the drawn model as they did with a physical 3D apparatus. We conclude that more scaffolding and directing should be included in the curriculum, making this connection as explicit as possible Note to assessors for this proposal: proposer was traveling and could not get access to a computer to shorten his pdf file to six pages, so please ignore the sixth page.

Mary Anne WellsEric EslingerHarry ShipmanThe Role of Darkness in Student Understanding About Light and VisionP-523-957-956-990

Several studies over the last twenty years reveal students' confusions when asked to explain how light propagates from source to object to observer. One variable that has not been directly incorporated into research is exposure to complete darkness, both prior to and during instruction. The common perception that light is not a prerequisite for sight' may be considered a faulty ontological assumption due to a lack of prior experience with total darkness. This paper will report results from a study conducted on darkness and vision with a sample of 154 students from an introductory astronomy course for non-science majors at a medium-sized, state- supported university. Data and analyses provide insight into students' conceptualization of light and vision in two elementary contexts, seeing a glowing bulb (luminous source) and an illuminated pumpkin (non-luminous source). Explanatory models based on prior instruction, prior exposure to total darkness, and simulated total darkness in the classroom reveal deficiencies in current light instruction and the profound influence that total darkness may have on naïve and instructed learners.

Meichun Wen Yi-Wen Lin

Domain-General and Domain-Specific Science Epistemological Beliefs of Science Students of Biology, Chemistry, and Physics Majors P-483-1041-1040-1074

Previous research shows a strong relationship between students' science epistemological beliefs and concept learning. Studies also reveal multiplicity and domain- specific characteristics of science epistemological beliefs, and students may hold different beliefs toward different domain knowledge. The purpose of this study is to understand college students' domain-general and specific science epistemological beliefs using two questionnaires and qualitative interviews. Sample of the study came from departments of Biology, Chemistry, and Physics of three universities, with a total of 429 15th- grade science majors. Results indicated that male students had more matured beliefs toward the inventive nature of science and the theory-laden quality of science inquiry than females. Physics and biology majors had different views toward the creative nature of science knowledge. Generally speaking, students with more previous science experiences including science club or laboratory activities held more constructivist-aligned epistemological beliefs toward science. Open-ended questions and interviews showed that college science students held domain-specific views toward biology, chemistry and physics knowledge. To describe their views about the relationships among the three knowledge domains, students drew diagrams of three circles and their relative positions, and results were analyzed and discussed in the study.

Sandra West

Preliminary Results of a Middle School Correlated Science/Math Pilot Project P-227-1627-1624-1654

Integration in science typically means making cross connections among science disciplines. Researchers suggest that making linkages or correlations between science and math allow enhanced understanding of specific concepts in each other's discipline by teaching connecting concepts. Although it seems intuitively appropriate, effective and recommended by both of the national science and math standards, there is little research to support this idea. We propose to address the minimal research regarding the effect on student performance of training middle school (grades 5-8) science and math teachers with a two-year pilot project. This project provided teachers with unique, intense and sustained professional development in science and math content and pedagogy and a method for integrating or correlating science and math. (See http://www.bio.txstate.edu/%7escied/MS_Science/, Table of Contents, Physics, Correlated Position PPt.) Initial qualitative and quantitative data on participants provide evidence of efficacy. During the school year state student math and science test scores from the pre-treatment year 2005 and post-treatment years 2006 and 2007 will be used to measure student cognitive gains because student performance is at the forefront of the world's emphasis on global economic competition. Research is needed to guide the use of resources to prepare a future STEM workforce.

Orvil WhiteValarie AkersonHuseyin ColakKhemmedwadee PongsanonScientific Modeling for Inquiring Teachers Network (SMIT N):The Relationship Between ElementaryTeachersViews of Scientific Modeling and Nature of ScienceP-78-137-136-173

This paper describes the results of the second summer workshop of a three-year program designed to serve K-6 teachers in sustained professional development. The results include the elementary teachers' understandings of (a) nature of science (NOS), (b) scientific modeling, and (c) connections between their NOS views and understandings of scientific modeling. The workshop included explicit reflective instruction on NOS (Lederman, 1992), scientific modeling (Van Driel & Verloop, 2002) and authentic inquiry practices (Hitt & Townsend, 2004). It was found that the teachers in the post workshop interviews showed improved views of NOS and the teachers began to make explicit connections between NOS and the different types of models and the purposes they serve. When comparing the differences in the open-ended statements on the pre and post model surveys a few items stood out as showing a descriptive change regarding teachers' perceptions and use of models.

Mary WhitfieldBruce PalmquistRobert FilsonLeslie Heizer-NewquistReform in Pre-serviceElementary Education; an examination of a university-community collegepartnershipP-236-1419-1418-1450

This study examines the impacts of a reformed elementary teacher preparation program in which students meet their undergraduate science requirements through a year-long series of interdisciplinary science courses as opposed to through a buffet of standard college intro classes. We are investigating the impacts of this program on: 1) Beliefs about the Nature of Science and scientific inquiry; 2) Teacher classroom practices. A unique feature of the project is its focus on community college students, who represent an important and growing segment of the future teacher population but who are only rarely represented in research studies. Research subjects include students who begin their education at a community college and then go on to complete a teaching certificate by either (1) remaining at the community college and taking all methods courses there or (2) transferring to a 4-year school to complete their degree. Preliminary analysis of data from a nature of science questionnaire reveals that participants can give canned responses to questions about what science is, but are on very shaky ground in the negative space of what science is not. This study is funded by the NSF Teacher Professional Continuum (TPC) program. Data presented here represent preliminary results from this on-going three-year study.

Eric Wiebe

Science Education Research Using Advanced Recording Technologies Q-494-895-894-928

While A/V technology has gotten increasingly more cost-effective, its deployment in instructional settings has typically not taken best advantage of its capabilities, resulting in low quality data that hampers the analysis process. This paper will outline a two-year process of the design and evolution of recording technology packages for use in a range of science education instructional settings. User needs were explored and analyzed through interviews with educational researchers and curriculum designers. These recording needs were matched with available technologies to create systems comprised of both off-the-shelf components and custom-built solutions. The paper will discuss the matching of research questions with the appropriate scale and type of recording. Standard scenarios developed from past experiences and interviews will be described along with appropriate matches to recording technology. Examples of data collection recording will be given.

Terry WildmanAndre GreenMary WolfeVinod LohaniKumar MallikarjunanDepartment-Level Curriculum Reform in Engineering:Conceptual Frameworks and Faculty ExperiencesQ-346-598-597-634

Changes in instructional methodologies are commonplace in engineering education; reform of an entire four-year curriculum is relatively rare. This paper describes the conceptual framing and faculty experiences associated with the redesign of the bioprocess engineering curriculum within the Biological Systems Engineering curriculum at a large southeastern research university. Using Jerome Bruner's 1960's notion of the spiral curriculum, the project involves reorganizing a traditional knowledge- based linear curriculum to engage students in progressively deeper levels of investigation of selected key themes that are critical to biological systems engineers. The redesign process also includes spiral alignment of the bioprocess curriculum with the freshman engineering program organized by the Engineering Education Department. The presentation discusses the spiral framework, its relation to contemporary learning research, and the challenges it poses for faculty who must learn new relationships with their content and their students.

Jennifer Wilhelm

Sonya Sherrod

Gender Differences in Lunar-Related Science and Mathematics Domains P-284-480-479-516

We report an examination on gender differences in lunar phases understanding of 211 middle level students. Two separate groups of students, instructed by the same teacher, participated in inquiry experiences as they studied the Moon and its phases. Middle level students interacted with the Moon through observations, sketching, journaling, two- and three-dimensional modeling, and classroom discussions. Students' understanding of the Moon's phases was measured through analysis of pre-and post-test results on the Lunar Phases Concept Inventory (LPCI). The LPCI was used to assess conceptual learning of eight science and four mathematics domains. We found male students to obtain greater significant gains than females in lunar and spatial understandings. Analysis of LPCI results showed the science domains with greatest gains in understanding for male students were orbital periodicity and cause of lunar phases and for female students, orbital periodicity and effect of lunar phase with change in Earthly location. The mathematics domain with greatest gains in understanding for males was geometric spatial visualization and for females, spatial projection. This research indicates that science and mathematics learning of lunar related concepts can be significantly improved by both sexes in an interactive, inquiry environment.

Jennifer WilhelmSonya SherrodKendra WaltersPre-service Teachers Experience an Interdisciplinary Project-Based Learning Environment

Q-284-646-645-682

We describe a design study that documented how 24 pre- service teachers (PSTS) experienced the mathematics and science associated with understanding the Moon and sky as they participated in project work within their integrated mathematics/science methods course. We examined how they applied the mathematics needed to accomplish project tasks that were situated in an astronomical context. Six groups of PSTS' project work were compared. Results showed groups having difficulties knowing how to apply basic mathematics, such as scaling, ratios, sine curves; thus requiring just in time' scaffolding lessons to facilitate project progress. We also analyzed the PSTS' pre- and post- scientific/mathematical understandings needed to understand lunar concepts. Our findings revealed PSTS making significant gains in both scientific and mathematical understandings. This research provides specific evidence on how interdisciplinary projects can be incorporated within the classroom and how a project-based environment can authenticate science and mathematics.

Kathy Williams

Integrating issues in science through the curriculum Q-724-1513-1512-1543

Helping college students learn to distinguish scientific facts from fiction, or at least be able to identify additional information needed to make that distinction and where/how to get it, is a challenge. Hopefully we can do this in science classes and across the curriculum. The objective of this teaching and learning experiment was to design a strategy to help students in freshman rhetoric classes learn to critically evaluate information on the Web about current scientific issues. A learning module was developed about Global Climate Change, using the public resource WebQuest, an inquiry-oriented activity that guides learners as they analyze, synthesize, and evaluate material from the Web. Two college classes were used, one composed of only biology majors and one with various majors. In groups, students evaluated selected websites on global climate change and considered specific aspects of the sites, such as content, resources, authors, and sponsorship of sites. In a town hall meeting, teams reported their results about the arguments and evidence presented in sites they examined. Final assessments showed that students successfully integrated information among disciplines of science, constructed scientific arguments and supported them with appropriate evidence, and gained new skills to evaluate scientific information from the Web.

Grant Williams John Clement

Identifying Model-Based Teaching Strategies: A Case Study of Two High School Physics Teachers P-506-1473-1472-1503

In this study, we attempted to the variety and levels of teaching strategies of two high school physics teachers utilizing the same model-based curriculum for circuit electricity. Diagrammatic representations of the teacher-student discourse patterns were developed from classroom transcripts in an attempt to better understand the nature of the whole-class conversational interactions taking place and form hypotheses about the co-construction of explanatory models. Follow-up interviews with each teacher were conducted in which they independently described their own teaching strategies in the same transcripts. In addition, we attempted to track the ratios of student and teacher idea contributions during the model-building process. The teacher moves that were identified are believed to occur on two distinct strategy levels: 1) those that support the dialogical or conversational elements of classroom interaction, and 2) those that support the cognitive model-construction processes of the students. While the two educators used different strategies at both levels, each teacher appeared to contribute to the higher-level goals of: promoting the use of observations (O), generating model elements (G), evaluating model elements (E), and modifying model elements (M) in what we refer to as OGEM cycles.

Paula Wilson George DeBoer

Determining the Appropriateness of Terminology in Content-Aligned Assessment of Middle School Students: Examples from Plate Tectonics Q-339-600-599-636

This poster describes how pilot testing is used to gain insight into student thinking about ideas tested in middle school about plate tectonics. The work described is part of a larger project to develop student assessment items in science and mathematics that are precisely aligned with content standards. Students responded to assessment items that are aligned to specific ideas in Benchmarks and Standards. In this poster, we focus on how pilot test data can be used to determine the appropriateness of specific terminology in clarification statements and related assessment items. Two significant results come from this work. First, in assessing student understanding of science ideas, the words that are chosen matter. Therefore, it is critical that assessment be based on carefully thought out and tested wording of those ideas. Second, asking students to explain why they selected each of their answer choices is an effective way of pilot testing multiple choice assessment items. The large data sets obtained with this methodology provide information from students across diverse geographical areas and student populations. The method provides a reliable way for a large number of students to contribute to the design of effective assessment for understanding of science ideas.

Catherine WissehrJim ConcannonLloyd BarrowEffects of the launching of Sputnik on science education in the United States: Preparing for the golden
anniversary of Sputnik I launchP-464-890-889-923

Effects of the launching of Sputnik on science education in the United States Preparing for the golden anniversary of Sputnik I launch. This paper explores the short- and long-term effects on science education in the United States following the launching of the Soviet satellite, Sputnik I. Sputnik served as a wakeup call to the American educational system and focused attention on the need for more rigorous math and science curricula. Discussed is the development of science education from the era of progressivism, through the Golden Age, and toward the reemergence of progressivism that exists in schools today. Lessons learned from these reforms are applied to the current social, political, and legislative climate that surrounds science education today.

Mihye WonSara SalloumDavid BrownComputer as Inquiry Partner for Deeper UnderstandingsP-515-935-934-968

There are many types of instructional uses of technology. Taxonomies of instructional use typically divide into two categories: uses in which the computer is in charge (e.g., computer assisted instruction), and uses in which the student is in charge (e.g., programming the computer). In this paper we suggest a third category the computer as inquiry partner. We present a study examining the metaphor of the computer as inquiry partner (Less Knowledgeable Peer, LKP). We employed a quasi-experimental design with 18 college students to compare the computer as inquiry partner context with the computer as directive tutor. The purpose of the study was to explore (a) how computer tutoring sessions help students' understanding advance; and (b) how the LKP context compares to the directive context in enhancing conceptual understandings. Participants in general gained better understanding of gear relations after the tutoring session. However, the computer as inquiry partner was better at leading students to understand the mathematical relationship. LKP participants showed greater engagement during the session and exhibited greater conceptual understanding and reasoning on the posttest. LKP participants took initiative to elaborate their thinking even when still confused. The computer as inquiry partners emerged as a feasible instructional use of technology.

Siu Ling Wong Man Wai Cheng Benny Yung

Professional development for teaching of the nature of science - What works best for in-service science teachers?

P-739-1564-1563-1593

In this study, in-service science teachers' development in the teaching of the nature of science (NOS) was traced through a series of teacher training events. The training includes (i) a two-day workshop to promote in-service teachers' understanding of NOS, (ii) pre-trial discussion on a set of instructional materials, (iii) class implementation, (iv) teachers' review and reflection on their classroom video of the trial lessons, (v) feedbacks by the authors on the lessons to the teachers, (vi) discussion on critical incidents between the authors and the teacher in preparation for a sharing session among other inservice teachers, (vii) sharing of the teachers' experience in their try-out with other in-service teachers. Questionnaires and interviews with teachers were used to probe the effectiveness of each component and to identify what works best in developing a teacher to teach about NOS. Our findings show that the actual classroom implementation and detailed review, reflection and discussion on the lesson video work best in enhancing the necessary pedagogical content knowledge and more importantly treasured most by the teachers. This result has significant implications on the design of teacher professional development programs which empower and position teachers to take on new initiatives.

Hsin-Kai WuYing-Shao HsuFu-Kwun HwangModeling a Complex System: Using Novex Analysis for Developing an Effective Learning ModuleP-416-735-734-769

The purposes of this paper are to present the design of a technology-enhanced learning module that was informed by a novice-expert analysis and to discuss high school students' development of modeling practices and conceptual understandings when they engaged in the module activities. The learning module is designed to help high school students understand that air quality is the results of complex interactions among air pollutants, topographic effects, and meteorological factors. Using the novice-expert analysis, we specified atmospheric scientists' modeling practices as learning objectives, designed a dynamic modeling tool in light of the knowledge bases of scientists and students, presented dynamic simulations to help students understand complex processes, and designed a range of learning activities to encourage model-based reasoning. One teacher and 36 tenth graders participated in the first implementation of the module. The test results show that students' understandings about air quality were significant improved after they engaged in the module. Throughout the module, students identified more major variables relevant to air pollutant dispersion, carefully controlled and manipulated variables to test their model, and became aware of limitations of their models. These findings suggest that the learning module is effective in helping students demonstrate expert-like modeling students.

Ying-Tien WuChin-Chung TsaiChun-Yen ChangThe relationships between high school students' cognitive structures regarding nuclear power and theirinformal reasoning on nuclear power usageP-579-1092-1091-1125

This study was conducted to explore the relationships between 44 eleven-grade students' cognitive structures regarding nuclear power and their informal reasoning on nuclear power usage. The data about participants' cognitive structures were collected with tape-recorded interviews, and the interview narratives were transcribed into the format of 'flow maps'. The students' informal reasoning on nuclear power usage was assessed with an open-ended questionnaire developed in the previous study, and their responses were analyzed with an integrated framework developed in the previous study. The results showed that the students, having more extended as well as more integrated cognitive structures, were more oriented to utilize multiple reasoning modes; those who, more frequently used higher-order information processing modes in organizing concepts, also tended to utilize multiple reasoning modes. Moreover, the more extended as well as the more integrated the students' cognitive structures were, the more they were oriented proceed higher-level reasoning; the more frequently an individual learner tended to utilize higher-level information processing modes in organizing concepts, the more he/she was oriented to achieve a higher reasoning level. In conclusion, this study showed some evidence that students' conceptual understanding regarding a socio-scientific issue was related to their informal reasoning on this issue.

Li Hua Xu David Clarke

Artefacts and Distributed Cognition: Towards a New Perspective on Science Learning P-524-1017-1016-1050

Our purpose in this paper is to propose distributed cognition (Hutchins, 1995; Hollan, Hutchins, & Kirsh, 1999) as a useful perspective on science learning. Deviating from the individualistic cognitive model, a significant shift in this perspective is its conceptualization of learning as constituted in both internal and external resources. Therefore, the research focus is on cognitive systems that include both participants and their environment, and on the public space of interaction. In this paper, we first elaborate the epistemological groundings of distributed cognition and introduce an analytical approach that was developed to study two videotaped science lessons. Using the detailed analysis of the empirical data, we explicate some key assumptions underlying traditional educational thinking and further reframe these assumptions from the perspective of distributed cognition. This paper opens up the possibility of employing distributed cognition as an explanatory framework to study learning in science classrooms and also serves as an invitation for studies that could further enrich the theory of distributed cognition.

Li-hsuan Yang

What do college students mean when they say they are interested or not interested in science? P-426-761-760-795

This study examined how college students perceived the nature of their interest or lack of interest in science and what factors they attributed their interest or lack of interest to. Twenty-four college students were interviewed to gain an understanding of their ideas and experience of science, their overall interest in science, their interest levels in four areas of science which were (1) learning science facts/concepts in school, (2) learning science facts/concepts outside of school, (3) figuring out scientific knowledge in school, (4) figuring out scientific knowledge outside of school, and the reasons for their interest or lack of interest. The constant comparative method of qualitative analysis was used for data analysis. The findings revealed no difference between the interested group and the uninterested group with regard to the understanding of the epistemological nature of science except that only students in the uninterested group described science as memorization. Most students had different levels of interest in the four areas of science. Almost all students who identified themselves as uninterested in science seemed to be very interested in some areas of science in some contexts. Reasons to account for the different levels of interest in different levels of science were discussed.

Olivia Yang Virginia Epps

Developing preservice elementary teachers science teaching efficacy in authentic context: A science methods course model with teaching experience through collaboration among university and local elementary school teachers. *Q*-714-1491-1490-1521

The study investigated the effectiveness of a science method course model on the development of the self- efficacy (Bandura, 1977) of preservice teachers (n=207) in teaching science. The model involves collaboration between the university and local elementary schools to provide preservice teachers with an authentic context of teaching science. Inservice teachers from the local elementary school (30) served as consulting teachers while each group of 4 preservice teachers prepare a lesson for their students. The results showed their science teaching self- efficacy measured by STEBI-B (Enochs & Riggs, 1990) increased significantly after the method course. Reflective essays from randomly selected samples (20) showed that the preservice teachers perceived experience with inquiry (62%), lesson planning (31%), and teaching experience (31%) as beneficial, and prior knowledge investigation (92%) as useful problemsolving strategies for instructional planning. Most preservice teachers planned to incorporate scientific inquiry (92%) into their future science instruction and showed commitment to providing student centered instruction (77%). Results from both quantitative and qualitative analyses indicated that the current model impacted significantly on the development of the preservice teachers' science teaching efficacy by providing a very effective source of information for self-efficacy development, performance accomplishment suggested by Bandura (1997). Implications for preservice teacher education are also discussed.

Senay Yasar Gohkan Ozdemir

Secondary Teacher Learning Assessed by the Quality of Lesson Plans Designed to Support Communication in Science Inquiry P-308-538-537-574

Abstract The purpose of this study was to investigate the effectiveness of a teacher development program through the evaluation of lesson plans designed by teachers. This research was conducted during a three-week workshop as part of a larger project called the Communication in Science Inquiry Project (CISIP). Teachers designed lesson plans to support scientific discourse while working as part of a learning community of teachers. We evaluated the lesson plans based on the degree of alignment with the CISIP objectives. The data consisted of forty three lesson plans created by eighteen teachers. A coding scheme and a 15-point rubric were developed for evaluation. The mean score indicated that the teachers applied the CISIP principles in their lessons with a 75 percent alignment. The effect size differences between science and English teachers were also calculated. We found that science teachers designed better lessons than did the English teachers. In addition, familiarity with CISIP principles and good team collaboration led to successful designs. Recommendations are made to increase the involvement of the English teachers and create support systems for all participants. Results of this analysis are also used to provide formative feedback to teachers.

Ozgul Yilmaz-Tuzun Mustafa Topcu

Validation of Junior Metacognitive Awareness Inventory (Jr. MAI) and Investigation of the Effect of Achievement on Metacognitive Skills of Elementary School Students P-174-284-283-320

The purpose of this study was to validate of Turkish version of Jr. MAI and to explore the effect of achievement on elementary school students' metacognitive skills. The Jr. MAI was administered to 315 students enrolled in fourth and fifth grades and 626 students enrolled in sixth, seventh, and eight grades of seven elementary schools. Exploratory factor analysis revealed two factors -knowledge of cognition, and regulation of cognitionfor the 4th and 5th, and 6th through 8th grade students. MANOVA analysis revealed expected trend among 4th and 5th students' achievement and their metacognitive skills. When students' success in science increased their metacognitive skills were improved. The results of MANOVA for 6th through 8th grades showed parallel findings with 4th and 5th grade students related to achievement and metacognitive skills that when students' success in science increased their metacognitive skills were also improved. Larry YoreBrian HandMack ShelleyDonna AlvermannNancy BrickhouseJonathan Osborne

Research Committee-sponsored symposium: The Gold Standard of Science Education Research Does One Size Fit All Problems?

S-773-1667-1664-1694

This symposium seeks to promote discussions about the Gold Standard for educational research. Numerous expert panels, reports, books, journal editorials, and NSF-sponsored conferences have addressed the scientific study of education and evidence-based practice; yet NARST has not had similar, formal deliberations. Given the USA's current political climate and other countries' desire to improve student performance across all grade levels, science educators should discuss how to balance administrators' demands for evidence- based practices and instruction programs with the need to pursue curiosity- driven research agendas that build fundamental, theoretical understanding of teaching and learning. Does the one size fits all' policy privilege specific research designs over evolving and changing design demands of ongoing inquiries, thus narrowing the range of worthwhile problems investigated?

Li-Ching You

The Social and Emotional Context of Task Conflicts P-741-1573-1572-1602

Following grounded theory (Strauss & Corbin, 1990), this process report focuses on underlying social and emotional context of task conflicts and its impact on group creativity. The results of a preliminary analysis of students' learning journals, group discussions, and interviews show that, whether task conflicts could be beneficial depends on a complex web of knowledge, value, role, status, task difficulty, emotional experience, and tolerance for conflict. Communicative competence is found to be important for conflict resolution. Implication to science education is discussed at the end of the article.

Betty YoungPaul Bueno de MesquitaMinsuk ShimKathleen GuglielmiAn Exploration of the Science Teaching Efficacy Beliefs of Pre-service and In-service Elementary TeachersP-77-375-374-411

The purpose of this study was to explore the science teaching efficacy beliefs of 57 beginning elementary teacher education students compared with the beliefs of 75 experienced elementary teachers who were further divided based on their opportunity for professional development in science teaching. The CAREERS (Change Associated with Readiness, Education, and Efficacy in Reform Science) project, a longitudinal investigation of multiple factors that are seen to contribute to high quality elementary science teaching, conducted a preliminary pilot study to assess one of these factors, self-efficacy in teaching science using the Science Teaching Efficacy Beliefs Instrument (STEBI) instrument. Findings show a surprising similarity among the groups on the two STEBI scales (i.e., personal efficacy and outcomes expectancy) with some notable differences on individual items. This study has raised some interesting questions: Do the methods students have a higher sense of science teaching efficacy because they are naive and do not know the complexities of teaching inquiry/discovery science? What science teaching conditions are associated with fluctuations in the efficacy construct? These are all important questions as teacher educators work to address the challenge of providing highly qualified, effective teachers of elementary science.

Benny YungFei Yin LoSiu Ling WongMan Wai ChengDerek HodsonInvestigating Teachersand StudentsConceptions of Good Science Teaching Through a Video-based SurveyInstrumentP-220-390-389-426

The way a teacher thinks about teaching influences the way they teach, hence the way their students learn, and ultimately their learning outcomes. Learning outcomes can be improved if there is a closer match between teachers' and students' conceptions of good' science teaching (CoGST). This paper reports on the development of a video- based survey instrument and its use in investigating the CoGST held by 110 teachers and 4024 students. Factor analysis reveals a CoGST model comprising 11 dimensions including: Establishing a clear learning purpose, Encouraging active experimentation, and Modelling data interpretation. Significant gaps between teachers and students on some of the dimensions are identified. This raises important questions of how these gaps can be addressed. This study is a timely response in the light of recent education reforms which demand new types of teaching and learning. Changes are clearly required in teachers' and students' conceptions of teaching and learning. By engaging teachers and students in commenting and talking about good' teaching, this study will contribute to the process of change. The innovation of using video-based survey instrument also opens up new possibilities in the field of conception studies/learning environment studies.

Molly YunkerJoseph KrajcikTina StanfordShawn StevensIdentifying the Big Ideas in NanoscienceP-150-1255-1254-1286

Scientific ideas resulting from emerging fields such as nanoscience are not addressed in the 7-12th grade classroom. Possible explanations include the interdisciplinary nature of nanoscience, lack of subject matter knowledge, and the novelty of the field. The United States is in need of a scientifically literate population and workforce, with an understanding of emerging fields of science. The National Science Foundation recognizes the need for learning goals, curriculum, and assessment to be aligned. In June 2006, we held a workshop to identify and clarify the big ideas in nanoscience. Thirty-nine experts in the fields of science education, learning sciences, and nanoscience identified and discussed the major concepts that are central to this field. The big ideas include 1) Properties at the nanoscale, 2) Size and scale, 3) Particulate nature of matter, 4) Self-assembly, 5) Modeling, 6) Tools, and 7) Nature of science and technology. Groups also developed a set of 7-12th grade learning goals for each big idea. The findings from this workshop will be useful for focusing student learning on emerging science concepts, providing direction for classroom teachers to focus teaching on these concepts, and for curriculum developers working on student materials. NARST members will be given the opportunity to discuss these findings from the perspective of their disciplines.

David Zandvliet

EE as a Context for Science Education P-772-1665-1662-1692

This invited symposium hosted by the new environmental education strand (14) will consider the unique contexts that environmental education may provide for science education and its associated research. The discussion will be prompted by brief presentations from invited panelists (above) that will examine the historical, present and future condition of environmental education activities at NARST. Participants will engage in facilitated discussions aimed at building capacity within the new strand while working towards a shared vision for future research dissemination activities hosted by the environmental education strand.

David Zandvliet

Learning Environments that Support Environmental Learning P-204-337-336-373

This study began as an inquiry into the effect of field experience on learning. We investigated the role that a sense of community and belonging in students has on learning- - specifically the impact of the teacherstudent interactions created in experiential programmes. As an integral part of the study we explored student perceptions of the learning environment' through the devlopment of a survey adapting scales from several widely used instruments. The study compared these perceptions within single discipline, classroom-based learning environments with perceptions within interdisciplinary, outdoor-based learning environments using the newly developed instrument. The study results describe how student participation in this type of programme changes students' expectations for their learning and for the educational learning environments they encounter in schools. We are continuing this inquiry with the development and validation of further instruments for example, the Place Based and Constructivist Environment Survey (PLACES) for use in environmental education settings.

Yevgeniya Zastavker Maria Ong Lindsay Page

Project-Based Learning in an Undergraduate Engineering Program: Exploring Student Engagement, Interest, and Motivation in Introductory Physics, Mathematics, and Engineering P-253-1321-1320-1352

This study addresses the effectiveness of project-based learning (PjBL) on engaging students, particularly women, in undergraduate science, mathematics, and engineering courses. Specifically, it examines how thematic content, integration of projects into disciplinary subjects, and hands-on activities impact student learning and engagement. This pilot exploration was initiated at a small engineering school using PjBL as its main pedagogical and curricular practice. The data (performance measures, 208-item survey, and student/faculty interviews) have been collected from two student cohorts comprising 150 lower-division undergraduates. We are using mixed methods of grounded theory, narrative summaries, and regression analyses to identify effective practices and outcome measures for comparative cross-cohort studies. Early results indicate that: 1) project themes provide students, especially women, with means to identify themselves as scientists and engineers; 2) projects present a depth versus breadth dilemma vis-à-vis integration into standard science, mathematics, and engineering subjects; and 3) there are likely strong, positive relationships between hands-on projects and student engagement levels. This work is among the first systematic studies to examine PjBL impact on engagement and motivation of underrepresented populations in their learning and desire to remain in science and engineering fields.

Dana ZeidlerBrendan CallahanKarey BurekTroy SadlerScott ApplebaumImproving Reflective Judgment in High School Students through Socioscientific IssuesP-349-605-604-641

The purpose of this investigation was to determine the efficacy of explicit Socioscientific Issues (SSI) embedded instruction over the course of an academic year on high school students' reflective judgment. The usefulness of the Reflective Judgment Model as a tool for assessing the value of SSI is found in the parallels that can be drawn between them. Both involve ill-structured problems that involve many differing opinions by students, and both require the ability to examine, analyze and combine scientific and normative evidence, and use that evidence to support a reasoned position. Results demonstrated both statistically significant gains within treatment groups with a moderately large effect size, as well as qualitative evidence revealing more sophisticated epistemological stances toward higher stages of reflective judgment.

Carla Zembal-Saul

Reizelie Barreto

Preservices Elementary Teachers Developing Understanding and Practices for Teaching School Science as Argument

P-477-861-860-895

In this qualitative case study, we provide an in-depth examination of the development of three preservice elementary teachers' understandings and practices for teaching science as argument. Participants were undergraduate seniors enrolled in a yearlong internship experience in a professional development school setting. The science methods course that is part of this experience is taught during the fall semester. In the methods course, preservice teachers learn science concepts by engaging in argumentation practices, and learn about science teaching by analyzing model lessons and video-based cases of classroom science teaching. Data sources for the study include participants' responses to seven video-based cases integrated into the methods course across the semester and videotape of participants teaching three consecutive science lessons at the end of the semester. A central finding of the study is that as preservice teachers developed more robust understandings of evidence and explanation, it informed their interpretations of science teaching in productive ways, most notably increased attention to discourse and subject matter learning in science. In addition, there was a close correspondence between developing understandings and initial science teaching practices, particularly engaging children in robust data collection and explanation building opportunities.

Hongqin Zhang Kathleen Davis

Too open? Too closed? How do different inquiry approaches influence middle school students science learning and their attitudes about science? P-608-1160-1159-1192

In this study, we explored a middle school science classroom where the teacher implemented inquirybased instruction. In her class, she used structured inquiry, guided inquiry, open inquiry and the coupled inquiry cycle. We explored how inquiry approaches influence students' science learning and their attitudes about science.

Meilan Zhang Chris Quintana

How do middle school students read science on the Web? P-691-1576-1575-1605

In recent years, the Web has been widely used by K-12 school teachers and students as an information source. However, empirical research on how students actually learn from the Web is limited. Particularly, we know little about how middle school students read online information to learn science. This study investigates the reading process when middle school students engaged in an online research task that lasted two weeks. Participants were 8 sixth-grade students at a public middle school. Students worked in pairs to explore self-generated scientific questions online. Multiple data sources were collected, including video recordings of students' computer activities, log files, students' artifacts, and classroom observational notes. Analysis of data shows that middle school students tend to quickly skim a website rather than stop to read. Even when they read, their reading is fragmented and opportunistic by randomly picking up several words in a site. As a result, their understanding derived from online resources is fragmented and limited. Therefore, scaffolding is needed to help middle school students engage in deep and meaningful online reading.

Heather Zimmerman Philip Bell

Seeing, doing, and describing everyday science: Mapping images of science across school, community, and home boundaries P-536-1484-1483-1514

To understand thinking and learning about science across social settings, we examine children s activities (and their reflections about their activities) in their school, homes and communities. In this work, we analyze elementary children s daily practices related to science across their everyday activities to understand the social organization of these activities, the discourse and social practices used in these activities relevant to science, and the scientific knowledge work that children undertake during their participation in activity systems. We employ an Everyday Expertise analytical framework to study the development of science understandings at three planes: individual learner, social groups, and societal/ community resources. Our research questions revolve around how multiple experiences combine to influence children s thinking about science, as well as their thinking about their participation in future science activities systems, we also conduct clinical interviews, ethnographic interviews, and participant self-documentation procedures to look at the participants conceptual understandings of science to compare thinking about science across cases. Findings from a cross case analysis of science learners are shared, as are two in-depth case studies of learning scientific practices across social settings.

Brian Zoellner

Prescription for the Classroom: Policy Actors Conceptions of Science When Crafting the Scientifically-Based Research Guidelines in NCLB Q-161-573-572-609

The No Child Left Behind Act has brought praise and criticism regarding the requirements that teaching methods and curriculum be supported by scientifically-based research (SBR) that emphasizes randomized-controlled trials. Policy actors, instead of merely setting research priorities and establishing funding, are delineating how education research should be conducted. I have posed the following research questions: What elements of the model were chosen and what made them compelling when crafting the SBR guidelines? How did policy actors' understandings and assumptions of medical science, and its organizational and governance structures, inform their choices? Using grounded theory and informed by the framework of Gieryn's (1999) cultural cartography, Stein's (2004) culture of policy, and Stone (2002) and Smith's (2004) notions of political symbolism, I will use the coding software Nvivo to conduct document analyses of pertinent congressional committee hearings and policy documents informing the creation and implementation of SBR. Of special interest is how policy actors view educational research, the role of science in policy making, and the solutions to educational research issues. This project will contribute to the social studies of science and educational policy fields by providing a case of how policy actors perceive, portray, and invoke science to meet policy ends.

Uri Zoller,Azaiza Ibtisam,Miri Barak,David Ben-ChaimCritical Thinking Promotion and Conceptualization in the Multicultural Context of High School ScienceTeachingP-336-578-577-614

The development of students' higher-order cognitive skills (HOCS), including critical thinking (CT), is a major goal of contemporary science education, worldwide. We have studied the disposition towards critical thinking (DTCT), CT capability of, and its conceptualization by, 12th grade high school students (N=44 and 57, respectively) and their science teachers in the Arabic and Jewish sectors in the multicultural educational context of the Israeli society. Based on our previously research-based findings concerning purposely implemented HOCS/CT-promoting teaching, assessment and learning strategies, we have found, not surprisingly, in this mixed qualitative and quantitative methods-based research, that the research students' conceptualization, DTCT and CT skill level are contingent on, and closely related to, their cultural, traditional and social background. Consequently, restructuring of HOCS- promoting science education through research in multicultural communities should be designed and applied while concurrently responding adequately to the particular cultural and traditional attributes as well as to their potential impact on the multicultural societies involved. The bottom line: If science teachers purposely and persistently practice HOCS-promoting science teaching in multicultural communities, there is a good chance for a consequent development of the capabilities of their high school students.


First Author Name	Page in Program		
Abd-El-Khalick, Fouad	146	Banerjee, Anil	40
Abell, Sandra	120	Bantwini, Bongani	45
Abi-El-Mona, Issam	90	Baptista, Mónica	68
Adadan, Emine	48	Baram-Tsabari, Ayelet	113
Adams, April	92	Barrett, Sarah	57
Adams, Paul	72	Bautista, Nazan	74
Adrian, Brian	99	Bayne, Gillian	115
Akcay, Behiye Bezir	109	Beeton, Renee	58
Akcay, Hakan	56	Bell, Philip	41, 108
Akerson, Valarie	82, 122	Bequette, Marjorie	72
Akom, George	59	Berg, Cheryl	136
Al Momani, Ibrahim	114	Berger, Joseph	44
Alexakos, Konstantinos	57	Berkes, Elizabeth	69, 141
Alozie, Nonye	42	Bernard, Warren	56
Alp, Elvan	47	Beuckman, Joseph	118
Alsop, Steve	65	Beyer, Carrie	79, 86
Andersen, Annemarie	132	Bianchini, Julie	122
Anderson, David	97	Biernacka, Beata	63, 99
Anderson, Janice	46	Binns, Ian	145
Annetta, Leonard	81	Black, Alice (Jill)	113
Apedoe, Xornam	69	Black, Kathie	112
Arnesen, Nina	84	Blades, David	70
Aronson, Isaak	78	Blakely, Alan	61
Arrow, Douglas	145	Blanchard, Margaret	51
Aryal, Bijaya	117	Bledsoe, Karen	117
Asghar, Anila	56	Blickenstaff, Jacob	79, 114
Ash, Doris	120	Blonder, Ron	72
Atwater, Mary	39	Blonstein, Jason	133
Atwood, Ronald	93	Bodner, George	112
Augustine, Line	115	Bolte, Claus	78
Austin, Barbara	141	Borda, Emily	142
Avraamidou, Lucy	68	Botzer, Galit	81
Ayala, Carlos	128	BouJaoude, Saouma	98, 146
Aydeniz, Mehmet	87	Bowen, G. Michael	126
Babcock, Elizabeth	50	Box, Cathy	112
Bae, Minjung	77	Brickhouse, Nancy	123
Baek, John	121	Brown, Bryan	122, 134
Baker, Dale	126	Brown, Sherri	105
Baldwin, Brian	58	Brückmann, Maja	84
Balgopal, Meena	67	Bryan, Lynn	52
Balinsky, Martin	49	Buck, Gayle	76, 118
Ballender, Glenn	66	Bulunuz, Nermin	85
Bamberger, Yael	132	Burke, Christopher	142

NARST Annual International Conference 2007

Cambell, Cora	60	Dagher, Zoubeida	145
Can, Bilge	109	Dahsah, Chanyah	97
Capobianco, Brenda	76	Daly, Shanna	69
Carleton, Loran	82	Darner, Rebekka	145
Carlone, Heidi	128	Davis, Elizabeth	134
Carr, Kevin	76	Davis, Kathleen	65
Carrier, Sarah	113	DeBoer, George	108
Cartier, Jennifer	93	DeFranco, Cristina	80
Carver, Jeffrey	88	Deguchi, Akiko	138
Cashion, Marie	141	Delgado, Cesar	52
Catley, Kefyn	56	Demir, Abdulkadir	56
Catlin, Janell	128	Desjardins, David	141
Cavagnetto, Andy	140	Dickerson, Daniel	80, 110
Cetin, Ayla	131	DiGiuseppe, Maurice	53
Chaiyen, Yaowares	97	Dillon, Justin	129, 146
Chambers, Joan	145	Dolan, Erin	91
Champagne, Audrey	129	Donna, Joel	134
Charmatz, Kim	47	Donnelly, Lisa	81, 118
Chen, Catherine	144	Donovan, Deborah	114
Chen, Jun-Yi	55	Dotger, Sharon	95
Chen, Peilan	96, 124	Dowd, Patrick	83
Chen, Shih-Wen	117	Doyle, Constance	113
Cheng, Man Wai	111	Dreon, Jr., Oliver	50
Cheng, Meng-Fei	89	Duit, Reinders	91
Cheng, Tzu	116	Duran, Emilio	137
Chinn, Pauline	59	Duschl, Richard	83, 134
Chiou, Guo-Li	63	Ebenezer, Jazlin	65
Chiu, Houn-Lin	81	Edmin, Christopher	115
Cho, In-Young	49, 68	Edmondson, Elizabeth	90
Choe, Seung-Urn	82	Edwards, Michael	141
Chu, Hye-Eun	119	Eibensteiner, Janice	69
Churach, Dan	94	Eklund, Jennifer	133
Clark, David	124	Elster, Doris	99
Clary, Renee	85	Enfield, Mark	65
Clement, John	125	Eskin, Handan	90
Coble, Jennifer	49	Eslinger, Eric	104
Colley, Kabba	106	Evans, Rosemary	99
Cone, Neporcha	132	Everett, Susan	126
Cook, Laurie	100	Fadigan, Kathleen	76
Cook, Michelle	54	Faikhamta, Chatree	50, 120
Cormas, Peter	107	Falcone, Tara	73
Crawley, Frank	127	Farland, Donna	95
Creighton, Laura	74	Feldman, Allan	51
Crippen, Kent	85	Fischer, Torsten	91
Cui, Lili	40	Fisher, Kathleen	110

Fleming, Michelle	68	Hanley, Daniel	115
Flick, Lawrence	104	Hanson, Deborah	104
Flynn, Lynnae	65	Hanuscin, Deborah	88
Forawi, Sufian	138	Harlow, Danielle	75
Forbes, Cory	86	Harrison, Allan	101, 135
Fowler, Samantha	48	Herrmann Abell, Cari	77
Fraser-Abder, Pamela	133, 133, 146	Hick, Sarah	49
Freeman, Carol	123	Hilson, Margilee	57
Freeman, Tonjua	45	Hitt, Austin	142
Friden, Kelley	75	Hobson, Sally	41
Furman, Melina	98, 143	Hofstein, Avi	143
Gagnon, Mark	116	Holt, Kiyra	79
Gaigher, Estelle	136	Hong, Jun-Euy	67
Galosy, Jodie	143	Houle, Meredith	121
Garik, Peter	75	Howard, Courtney	80
Garritz, Andoni	69	Howes, Elaine	58
Gatling, Anne	73	Hsu, Liang-Rong	70
Gay, Andrea	114	Hsu, Pei-Ling	72, 104
Ge, Yun-Ping	127	Hsu, Ying-Shao	96
Geer, Uric	136	Huang, Tingho	47
Gengarelly, Lara	64	Huang, Ya-Ling	124
Gilmer, Penny	40	Hübinger, Regina	68
Givvin, Karen	144	Huffman, Douglas	45
Glasser, Howard	58	HUI, Ching Sum	73
Glasson, George	89	Hume, Anne	60, 138
Glemnitz, Ina	55	Hutchins, Kristen	43
Gogos, Arhonda	77	Hutchinson, Kelly	51
Goldman, Daphne	94	Huziak-Clark, Tracy	143
Goldston, M. Jenice	128	Ibrahim, Sheliza	71
Gomez-Zwiep, Susan	140	Inan, Hatice	41
Gonzalez, Elizabeth	78	Isiksal, Mine	114
Grady, Julie	64	Jackson, David	129
Green, Andre'	66	Jacobs, Christina	56
Grindstaff, Kelly	118	Jarvis, Tina	86
Groome, Meghan	48	Johnson, Carla	87, 103
Grove, Crissie	51	Johnson, Heather	42
Grueber, David	133	Johnston, Carol	79
Gunckel, Kristin	86	Jones, M. Gail	140
Hacieminoglu, Esme	64	Ju, Huang	71
Hagevik, Rita	75	Kahveci, Ajda	100
Hainnu, Rebecca	89	Kahveci, Murat	67
Hammrich, Penny	113	Kalita, Spartak	81
Han, JaeYoung	71	Kalvaitis, Darius	123
Handa, Vicente	50	Kang, Allison	100

Kang, Nam-Hwa	111	Liang, Jyh-Chong	109
Kara, Yilmaz	115	Liang, Xin	114
Kauertz, Alexander	52	Libarkin, Julie	119
Kaya, Sibel	72	Lin, Chia-Ching	95
Kazempour, Mahsa	136	Lin, Chien-Liang	79
Khourey-Bowers, Claudia	97	Lin, Jing-Wen	90
Kieren, Corinna	68	Lin, Miao-Hui	75
King, Amanda	80	Lin, Show-Yu	130
King, Donna	60	Lin, Shu-Fen	74
King, Heather	49	Lin, Tzu-Chiang	118
Kirch, Susan	67	Lin, Yuan-Cherng	78
Kisiel, James	71, 92	Lindahl, Britt	100
Kittleson, Julie	139	Liu, Chia-Ju	130
Klymkowsky, Michael	67	Liu, Lei	124
Ko, Eun-Kyung	82	Liu, Shiang-Yao	83, 95
Koballa, Thomas	73	Liu, Xiufeng	39
Kochhar, Jeanetta	78	Lotter, Christine	44
Koehler, Catherine	78	Loving, Cathleen	92
Koomen, Michelle	139	Luce, Morgan	67
Koul, Rekha	124	Luehmann, April	71, 142
Kozoll, Richard	50	Luera, Gail	67
Krajcik, Joseph	51	Lundeen, Cynthia	50, 75
Krockover, Gerald	119	Lundström, Mats	59
Kruatong, Tussatrin	92	Lynch, Sharon	42
Kuhn, Leema	41	Lynn, Valery	131
Kuo, Pi-Chu	66	MacDonald, Leo	71
Kwan, Jenny	145	Macdonald, Maritza	71, 75
Labudde, Peter	84	Maeyer, Jenine	126
Ladewski, Barbara	138	Makki, Nida'a	56
Laius, Anne	67	Malone, Kathy	103
Lambert, Julie	47	Maltese, Adam	92
Landel, Carolyn	114	Mamlok-Naaman, Rachel	146
Lebak, Kimberly	43	Manoli, Constantinos	117
Lederman, Norman	55	Marbach-Ad, Gili	43, 72
Lee, Eunmi	42, 63	Marcum-Dietrich, Nanette	80
Lee, Huei	80	Marshall, Karen	132
Lee, Hyunju	122	Martin, Sonya	88, 121
Lee, Sung-Tao	139	Martinez, Patricia	42
Lehner, Ed	118	Martin-Hansen, Lisa	74
Leonard, Mary	48	Matthews, Michael	116
Leonhardt, Nina	133	Mawn, Mary	64
Levy, Abigail	124	Mawyer, Kirsten	112
Lewis, Elizabeth	127	McCalla, Serena	64
Li, Min	52	McCallie, Ellen	43

McCollough, Cherie	49	Oliveira, Alandeom	66
McComas, William	79	Oliver, Leslie	128
McConnell, Tom	57	Olson, Eric	107
McDonald, James	110	Omoifo, Christiana	131
McDonald, Scott	97	Ongel-Erdal, Sevinc	73
McGaughey, Maisy	108	Osborne, Jonathan	133
McGinnis, J. Randy	117	Osisioma, Irene	132
McNeill, Katherine	41	Owen, Thomas	53
Meichtry, Yvonne	59	Owens, Trevor	53
Merritt, Joi	96	Ozdemir, Gohkan	127
Milne, Catherine	40	Padilla, Kira	116
Minogue, James	116	Pappas, Christine	111
Mogge, Sabine	111	Park, Eun Jung	63, 124
Moin, Laura J.	73	Park, Soonhye	57
Moll, Rachel	130	Park Rogers, Meredith	41
Monhardt, Rebecca	123	Passmore, Cynthia	41
Moore, Felicia	88	Patterson, Philip	130
Morrison, Judith	74	Patton, Bruce	126
Mortimer, Eduardo	146	Pearson, J.	62
Moscovici, Hedy	73	Peck, Debby	141
Mumba, Frackson	103	Pedretti, Erminia	50
Murphy, Colette	98	Peker, Deniz	59
Musikul, Kusalin	107	Pelaez, Nancy	47
Myers, Michelle	79	Peters, Erin	138
Narayan, Ratna	42	Peterson, Michael	138
Ndunda, Mutindi	65	Phillips, Marianne	121
Nehm, Ross	52	Phillipson-Mower, Teddie	145
Nelson, Tamara Holmlund	77, 106	Phipps, Molly	85
Neufell, James	77	Pitts, Wesley	115
Neuhaus, Birgit	48	Plummer, Julia	54
Newman, Jr., William	63	Potvin, Patrice	90
Niaz, Mansoor	53	Pouliot, Chantal	98
Nichols, Dianna	51	Price, Norm	125
Nielsen, Wendy	139	Priemer, Burkhard	130
Norby, RenaFaye	136	Prime, Glenda	144
Nordine, Jeffrey	64, 96	Pringle, Rose	128
Novak, Joseph	39	Puengpang, Nantarat	142
Novodvorsky, Ingrid	119	Qablan, Ahmad	145
Nugent, Gwen	93	Rannikmae, Miia	76
Ochsendorf, Robert	87	Rebello, N. Sanjay	40, 41
O'Donnell, Carol	99	Reeve, Suzanne	84
Ogan-Bekiroglu, Feral	126	Reiss, Michael	86
Ogunniyio, Meshach	88	Rennie, Leonie	60, 83
Olitsky, Stacy	70, 140	Riggs, Eric	137

NARST Annual International Conference 2007

Riley, Joseph	104	Shin, Yoonjoo	68
Riopel, Martin	46	Shroyer, Margaret	87
Rivard, Léonard	118	Shwartz, Yael	54
Roberts, Ros	128	Siegel, Marcelle	80
Rogers, Meredith	41	Sikkes, Ryan	140
Rop, Charles	117	Silk, Eli	103
Rose, Sara	119	Simmons, Patricia	89
Roth, Kathleen	144	Singer, Jonathan	44
Rowe, Olga	85	Siuda, JoElla	66
Rowell, Patricia	43	Slough, Scott	81
Rozelle, Jeffrey	113	Smetana, Lara	46
Rumann, Stefan	97	Smith, Leigh	87
Rushton, Greg	44	Smithey, Julie	120
Ruth, Lisa	44	Song, Youngjin	120
Saderholm, Jon	68	Sosu, Edward	116
Sadler, Philip	58	Southerland, Sherry	76, 134
Sadler, Troy	91	Stains, Marilyne	131
Saka, Yavuz	57	Stephens, Lynn	125
Salloum, Sara	81	Sterling, Donna	57
Scantlebury, Kate	53	Stevens, Shawn	70, 86
Schalk, Kelly	69	Stroud, Nicholas	71, 131
Scharmann, Lawrence	46	Stuessy, Carol	64
Schen, Melissa	70	Stylianidou, Fani	131
Schneider, Rebecca	138	Sullenger, Karen	141
Schroeder, Carolyn	104	Sunal, Dennis	125
Schussler, Elisabeth	139	Swami, Piyush	45
Schwartz, Renee'	98	Tabone, Chyrisse	126
Schwarz, Christina	86	Tal, Tali	47
Schwille, Kathleen	144	Talanquer, Vicente	131
SCOTT, Philip	91	Talsma, Valerie	79
Seiler, Gale	58,70	Tan, Edna	94
Semken, Steven	122	Taraban, Roman	48
Serin, Gökhan	66	Taylor, Amy	105
Seung, Eulsun	105	Taylor, Joseph	55
Shady, Ashraf	115	Thomas, Julie	113
Shanahan, Marie-Claire	100	Thomas, Megan	43
Sharma, Ajay	112	Thompson, Jessica	58
Shaw, Jerome	45	Thomson, Norman	46
She, Hsiao-Ching	130	Tillotson, John	106
Sheffield, Rachel	63	Timmerman, Briana	77
Shepardson, Daniel	110	Tobin, Kenneth	137
Sherron, Todd	107	Tockus-Rappoport, Lana	54
Shim, Minsuk	93	Toolin, Regina	106
Shin, Namsoo	52	Topcu, Mustafa	80

Toth, Eva	70	Xu, Li Hua	96
Trautmann, Nancy	105	Yang, Li-hsuan	139
Treagust, David	40	Yang, Olivia	74
Trendel, Georg	84	Yasar, Senay	127
Tretter, Thomas	56, 78	Yilmaz-Tuzun, Ozgul	93, 139
Trundle, Kathy	90	Yore, Larry	95, 101
Tsurusaki, Blakely	110	You, Li-Ching	55
Tuan, Hsiao-Lin	63	Young, Betty	132
Tuckey, Steven	98	Yung, Benny	91
Tzou, Carrie	108	Yunker, Karaen	93
Ucar, Sedat	85	Yunker, Molly	94
Upadhyay, Bhaskar	96	Zandvliet, David	59, 82
Uysal, Sibel	127	Zastavker, Yevgeniya	125
Valanides, Nicos	116	Zeidler, Dana	59, 112
Vallender, Glenn	66	Zembal-Saul, Carla	74
van Eijck, Michiel	82	Zhang, Meilan	115
Van Sickle, Meta	105	Zimmerman, Heather	108
Vanmali, Binaben	140	Zoellner, Brian	82
Varelas, Maria	66	Zoller, Uri	112
Wackermann, Rainer	106	Zucker, Andrew	109
Wahbeh, Nader	90		
Waldrip, Bruce	55, 65		
Wallace, Robert	133		
Wallace, Tamara	134		
Wang, Chia-Yu	73		
Watson, William	121		
Wee, Bryan	89		
Weinburgh, Molly	142		
Weizman, Ayelet	48, 111		
Wells, Mary Anne	119		
Wen, Meichun	98		
West, Sandra	140		
White, Orvil	109		
Whitfield, Mary	98		
Wiebe, Eric	81		
Wildman, Terry	69		
Wilhelm, Jennifer	74, 100		
Williams, Grant	125		
Williams, Kathy	70		
Wilson, Paula	77		
Wissehr, Catherin	100		
Wong, Siu Ling	88		
Wu, Hsin-Kai	78		
Wu, Ying-Tien	111		



springer.com

The



2006 WINNER

nternational information industry awards

Join the Winner!

Springer, the world's largest science, technology and medicine book publisher, was recently awarded the prize for the Best STM Information Product of 2006 for the Springer eBook Collection.

You are invited

to discuss publication of your research in our renowned collections in Science Education, reaching an audience of students, scholars and professionals around the globe via Springerlink with 16,000 libraries connected. Your next fully searchable and printable eBook can be among the 3,000 new Springer titles to be added to Springerlink every year.



I look forward to meet you in the Springer booth

Harmen van Paradijs Publishing Editor Education harmen.vanparadijs@springer.com



- Check out the new book by Bill Atweh, Angela Calabrese Barton, Marcelo Borba, Noel Gough, Christine Keitel, Catherine Vistro-Yu and Renuka Vithal: Internationalisation and Globalisation in Mathematics and Science Education
- ► Find information on our journals such as: Science & Education, Research in Science Education, Cultural Studies in Science Education and more!
- Check out the latest books in the Science & Technology Education Library, including the new book edited by Beth A. Wassel and Ian Stith: Becoming an Urban Physics and Math Teacher - Infinite Potential

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

