Contributed Talks – Abstracts

Students’ integration methods for first-order differential equations
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While indefinite integration and solving for the value of the integration constant is a technique often stressed in math classes, physicists more often rely on choosing physically relevant limits of integration. We examine intermediate mechanics students’ use of boundary conditions in mathematical and physical contexts though small-group interviews and exam results. In a purely mathematical context, students typically depend on a memorized solution or on indefinite integration to find the general result. In both situations, they then use the boundary condition to find the value of the integration constant. When presented with physics problems involving unexpected limits, students often choose inappropriate limits of integration based on what “seems right” or use indefinite integration. Because our data follows individual students over many weeks of instruction, we can also discuss the evolution of student use of indefinite and definite~integrals.

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Equity issues that affect mathematics teaching and learning with technology
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Research indicates that computers and calculators have great potential to facilitate learning and transform mathematics instruction at all levels. Yet inequities that arise from differential access to and use of educational technology can limit the impact of technology-based instruction for groups characterized by gender, ethnicity, income level and ability. Equity issues that affect students may involve differences in: (a) opportunities to learn (physical access); (b) educational treatment (how technology is used, by whom); and (c) educational outcomes (effects on achievement, attitudes and motivation). This presentation will highlight research on inequities in technology access and use at school and home, discuss how the differences can affect mathematics learning, and suggest pedagogies that may foster more effective technology use for under-represented groups in mathematics.

Teaching physics and mathematics using critical agency student-lead enactments
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Critical physics agency [1] is defined as rigorous physics pedagogy, involving extensive student engagement, and based on critical feminist theory and Freirean educational philosophy. Similarly, critical mathematical agency [2] uses this approach within the context of mathematics instruction. Critical agency is an important way to enhance students’ access to and success in mathematics and physics, as well as the potential to empower students to improve the quality of their lives. In this talk, we will present examples of middle school and early high school students enacting critical agency in physics and math, and engage the audience in a sample exercise involving critical agency.

1. Basu, Sreyashi Jhumki. (2004). Understanding How Low-Income, Minority Students Express Agency in a 9th
Grade Physics Classroom Developed with Expectations of Curricular Rigor and Student Engagement. Doctoral
Dissertation Proposal. New York: Author; (2006). How Urban Youth Express Critical Agency in a 9th Grade Conceptual Physics Classroom. Presentation to the Steinhardt School of Education, New York University. New York: Author.

2. Turner, Erin Elizabeth. (2003). Critical Mathematical Agency: Urban Middle School Students Engage in Mathematics to Investigate, Critique, and Act Upon Their World. Doctoral Dissertation. Austin, TX: Author.

An investigation into the change in the van Hiele level of understanding geometry of preservice
elementary and secondary mathematics teachers
Kathleen Chesley Knight, M.S.T.
Graduate (2006), UMaine Master of Science in Teaching Program
University of Maine

In August of 2005 changes to the Secondary Mathematics Teaching Certificate were implemented which eliminated the requirement for 35 credit hours of undergraduate mathematics in specific content areas such as geometry, calculus, statistics and probability. In its place is the requirement for 24 credit hours of mathematics content and successful completion of the PRAXIS II Mathematics Content Exam. These rule changes effected this investigation into the level of understanding geometry of pre-service elementary and secondary mathematics teachers, based on the van Hiele model, both before and after completion of the geometry course currently required by their education program of study.

A classification scheme for categorizing concept inventories
Rebecca Lindell, Ph.D.
Southern Illinois University Edwardsville

Since the development of the Force Concept Inventory (FCI), there as been a heightened interest in developing other concept inventories to assess students understanding of a phenomena. As more and more of these instruments are created, it must be made self-evident to test users that not all tests are created equal. We claim that there are three non-overlapping types of concept inventories and that the Science education research communities have an obligation, through peer review, to label any concept inventory as one of these three types of tests: (1) Local Tests, (2) Efficacy Tests, and (3) Diagnostic Instruments. We propose these distinctions based on differences in their development methodology. In this talk we will present evidence for this new classification scheme, as well as provide an analysis of the FCI.

A comparative study of how students understand stem cells
Jonathan Moyer
MST Candidate
University of Maine

The subject of stem cells is an ideal context of study for biology education, covering important concepts such as cell division and cell differentiation. Furthermore, the potential medical applications of stem cell research add health and biotechnology dimensions to the topic. Finally, the vigorous debate surrounding embryonic stem cell research highlights the social aspects of science and is immediately engaging.

As part of a research project on the effectiveness of an inquiry-based curriculum in biology, we are assessing two related curriculum units on stem cells based on research at the Jackson Laboratories, administered in parallel to students in two AP biology classes in a Maine high school.

In this experiment, one class participates in a lecture-based version of the unit while the other class participates in an inquiry-based version of the unit. Pretests will capture initial student conceptions of stem cells, while posttests will determine the effectiveness of one teaching method over another. Individual student interviews yield further insight into their understanding.

We describe the development of the curriculum and the assessments, as well as results from implementation.

Investigating the effects of teaching mathematics in a physics class
Michael A. Murphy, M.S.T.
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University of Maine

Much research has been conducted on identifying the problem of students’ apparent inability to use previously learned mathematics in introductory college level physics courses. I present the results of a study that examines the effects of teaching mini-mathematics classes within the setting of a physics laboratory on a repeated basis throughout the course of a semester. We will look at the effects of this treatment on both physics examination scores and a mathematics assessment designed for use in the study.

In-service primary school teachers in a force and motion workshop
David Nelson, M.S.T.
Graduate (2006), UMaine Master of Science in Teaching Program
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Many elementary teachers are not properly prepared to handle basic concepts in force and motion, which are part of many state and national elementary science standards. Professional development options to address these deficiencies range from multi-week courses to short courses or workshops. To study the impact of a concentrated workshop on elementary teacher conceptual understanding and self-efficacy, we developed and facilitated a one-week, inquiry-based force and motion workshop with an explicit epistemological component. We used the Force
and Motion Conceptual Evaluation (FMCE) to gauge conceptual understanding, and the Maryland Physics Expectations Survey (MPEX) and Science Teaching Efficacy Belief Instrument (STEBI) to evaluate teacher attitudes, beliefs, and expectations about teaching and learning physics. Data show the workshop produced fairly strong affective and self-efficacy gains across the board, but only conceptually localized content gains. We discuss the results and implications for expectations of short professional development activities.

How student understanding of academic language relates to achievement in high school
chemistry
Peggy LaBrosse
Science Department Coordinator
Hollis Brookline High School

How students learn relates to their understanding of language, specifically the academic language used in instruction, dialog, and assessment. Educators use academic language in the context of science education without necessarily scaffolding its meaning for students, which may increase cognitive load (Paas et al., 2003). Learning science, specifically chemistry, involves three levels — the symbolic, the submicroscopic, and the macroscopic — laden with technical language (Johnstone, 1991). Many of the words used in science are metaphors for abstract ideas or words that have a common meaning as well as a technical meaning. Thus, in many ways, learning science is like learning a new language. A review of the literature shows that non-technical words used in science can be troublesome for students. However, the relationship between student knowledge of non-technical words in science and achievement in chemistry has not yet been studied.

Collaborative learning in an online community of science learners
Arlene Jurewicz Leighton
Jason Academy

The Jason Academy offers online graduate science courses to pre service and in service teachers located worldwide. Many participants are second career learners who have chosen to become science teachers.  Best practices in face to face science teaching and learning can happen in a virtual learning environment. In many instances more time can be spent reflecting upon and providing feedback on science ideas generated by both the instructor and participants in a collaborative learning model.

The Jason Academy courses were part of a 2004-2005 SRI International evaluation to determine online course effectiveness. Course participants in this evaluation reported gains in understanding difficult science concepts and learning new methods for teaching science to increase student interest and understanding.

Mathematical methods in the natural sciences: A self-paced, applied approach
Michael Vorwerk, Ph.D.
Assistant Professor of Environmental Science
Westfield State College

Students enter college with varying mathematical backgrounds and preparation. In many science programs, much time is taken up in lower level courses teaching mathematical concepts that should already be familiar to all students. To address this lack of mathematical preparation, the biology department at Westfield State College requested a mathematics professor and environmental science professor to develop a course that would meet the goal of giving all entering science students a base of applicable math knowledge and skills. Faculty from many different science departments helped select topics to be covered. The emphasis was placed on hands-on and applied applications over theory. The mathematical concepts are taught as tools to address common science problems. The course was designed to fill gaps in the students’ mathematical preparation and to bring all students to a comparable level. This poster describes the evolution of the course from a 50/50 lecture/lab approach to an innovative, selfpaced, guided learning model. We address the problems and advantages of both approaches as well as possible future directions. The efficacy of the course is examined using student data as well as student and faculty testimonies.