CONFERENCE PROGRAM

Conference Hosts

Center for Science and Mathematics Education Research

The Center for Science and Mathematics Education Research at The University of Maine integrates research in student learning, research in teacher beliefs, and assessment of curricula into University-based research and training in science and mathematics education.

The main objectives of the Center are to:

- rebuild introductory courses in mathematics and the sciences based on mathematics-, chemistry-, earth science-, and physics-centered education research
- create attractive, content-rich teacher preparation and continuing education options for mathematics and science teachers that integrate content and pedagogy
- spearhead partnerships with public school teachers and University faculty to understand how student interest and achievement in mathematics and science are enhanced
- develop materials to form the basis for a statewide or national curriculum based on cultivating mathematics and science thinking through inquiry models.

The Center aims to become a source of well-qualified science and mathematics teachers for grades K-12 as well as a leader in creating coherent, developmentally-appropriate curricula for mathematics and science for grades 6-16.

Center projects are funded by the U.S. Department of Education Fund for the Improvement of Education Award Number R125K010106, the Howard Hughes Medical Institute, and a gift from the Fleet National Bank, a Bank of America Company and Trustee of the Lloyd G. Balfour Foundation. For further information about the Center and its projects, please contact Professor Susan R. McKay, Center Director.

Maine Mathematics and Science Teaching Excellence Collaborative

This project is a collaborative effort among three campuses of the University of Maine System and the Maine Mathematics and Science Alliance; the three campuses are the University of Maine at Farmington, The University of Maine, and the University of Southern Maine. The main purposes of the project are to

- increase the number of qualified teachers of mathematics and science (6-12) in the state of Maine
- improve the quality of the teacher education programs at each of the three campuses by bringing together faculty from the colleges of education, faculty from the colleges of arts and sciences, students in the different programs, and K-12 in-service teachers in mathematics and science to work collaboratively toward these goals.

Teacher preparation is the responsibility of faculties of both colleges of arts and sciences and colleges of education. Only through the integration of correct content and effective pedagogy can we provide the best education to K-16 children.

This project is funded by the National Science Foundation's Division of Undergraduate Education Collaboratives for Excellence in Teacher Preparation (CETP) program award number 9987444.

Keynote Speakers

Sunday, June 20, 2004
7:00 PM to 7:45 PM
Wells Main Dining Room

Teacher as Learner: Undergraduate Curriculum Innovation and Assessment of Student Achievement

Rosemary R. Haggett
Director, Division of Undergraduate Education
National Science Foundation, Arlington, VA
rhaggett@nsf.gov

The opportunity for faculty and their institutions to have a major impact on undergraduate education is greater than ever. Increased national recognition of the importance of science, technology, engineering and mathematics (STEM) education, coupled with rapid growth in new teaching and learning technologies, innovations in preK-12 education, increased understanding of how students learn, and successful interdisciplinary approaches, create new opportunities for improving the undergraduate educational experience. These developments provide the foundation for efforts to achieve excellence in STEM undergraduate education for all students.

What can we do to ensure that undergraduate curriculum innovation proceeds as rapidly as possible? We know that students who are active learners, who regulate their own learning and change their strategies as necessary, learn with understanding and transfer their learning more effectively. How can faculty become "active learners" themselves in order to improve their students' learning outcomes? How can they use what they learn to speed the cycle of innovation and accomplish these improvements in undergraduate education?

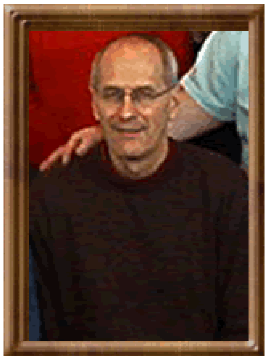
Tuesday, June 22, 2004
6:45 PM to 7:30 PM
Wells Main Dining Room

Developing Research-based Curricula: Examples from the CIPS and PET projects

Fred M. Goldberg
Center for Research in Mathematics and Science Education
San Diego State University, San Diego, CA
fgoldberg@sciences.sdsu.edu

CIPS (Constructing Ideas in Physical Science) is a yearlong middle school physical science curriculum (http://cpucips.sdsu.edu/web/cips), and PET (Physics for Elementary Teachers) is a semester-long curriculum for prospective or practicing elementary teachers (http://cpucips.sdsu.edu/web/pet). Both curricula use a pedagogy where students make explicit their initial ideas, perform experiments to test their ideas, work through a sequence of questions to help them make sense of the evidence, engage in whole class discussions to reach consensus, and apply the final ideas to new situations. In this talk I will show movies from both the CIPS and PET classrooms and use them as a context to discuss how research on student learning of physics informed the development of the curricula.

Invited Speakers:



Richard A. Beer
Middle School of the Kennebunks, Kennebunk, ME
Curriculum Research & Development Group
University of Hawaii at Manoa, Honolulu, HI

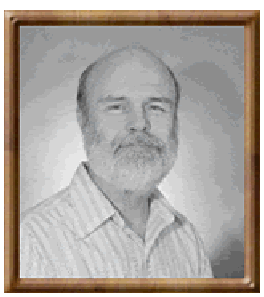
Introduction to FAST: Teaching Science as Inquiry
Monday Workshop Session, W3
and
FAST Professional Development: An Essential Component to Success
Tuesday Workshop Session, W11

Dr. Thomas J. Greenbowe
Department of Chemistry, Iowa State University, Ames, IA

Student Difficulties with Chemical Processes Involving Heat Exchange During Simple Calorimetry Experiments
Session S1-2

Dr. Randal R. Harrington
The Blake School, Minneapolis, MN

Applications of Research to Improve High School Physics Classes: Physics First through AP Physics
Session S5-2



Dr. Clyde Freeman Herreid
Director of the National Center for Case Study Teaching in Science
University at Buffalo, State University of New York, Buffalo, NY

Teaching and Learning with Case Studies: What Do We Know?
Session S6-1

Dr. Eric J. Knuth
Department of Curriculum and Instruction
University of Wisconsin, Madison, WI

Middle School Students' Production of Mathematical Justifications
Session S2-1

Dr. Joseph S. Krajcik
School of Education, University of Michigan, Ann Arbor, MI
Project-based science: What's the evidence that students learn?
Session S3-1

Dr. Julie C. Libarkin
Department of Geological Sciences, Ohio University, Athens, OH
A Tale of Three Theories: Development of the Geoscience Concept Test
Session S3-2

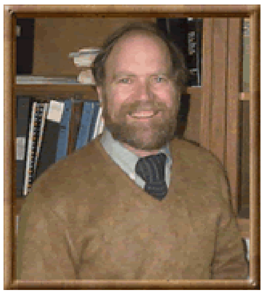
Dr. David E. Meltzer
Department of Physics and Astronomy, Iowa State University, Ames, IA
Investigation of Students' Reasoning in Thermodynamics and the Development of Improved Curricula
Session S1-3

Dr. Paula Messina
Department of Geology, San Jose State University, San Jose, CA
The Earth Science Placement Anomaly: Suggestions for Status-stepping and Strategies for Success
Session S5-3

Dr. Daniel C. Orey
The Department of Teacher Education and the CSUS Learning Skills Center
California State University-Sacramento, Sacramento, CA
The Algorithm Collection Project (ACP)
Session S2-2

Suzi D. Shoemaker
Casa Verde High School, Casa Grande Union High School, District #82
Casa Grande, AZ

A Model-Centered Approach to Earth Science Instruction
Session S5-4



Dr. Marshall D. Sundberg
Department of Biological Sciences, Emporia State University, Emporia, KS

Assessment: Quantitative plus Qualitative produces Quality
Session S3-4

Gregg Swackhamer
Glenbrook North High School, Northbrook, IL

Measuring Modeling
Session S1-4

Dr. Patrick Thompson
Department of Teaching & Learning, Vanderbilt University, Nashville, TN

Cross-talk and Miscommunication in Thinking about Teaching Statistics
Session S4-1

Dr. Gabriela C. Weaver
Department of Chemistry, Purdue University, West Lafayette, IN

Examining Student Use of a Web-enhanced DVD as an Instructional Supplement
Session S1-1

Dr. Donald B. Young
Curriculum Research and Development Group
University of Hawaii at Manoa, Honolulu, HI

Foundational Approaches in Science Teaching (FAST), An Enduring Curriculum: Its Theoretical and Pedagogical Foundations
Session S3-3
and
FAST, An Enduring Curriculum: Data on Effectiveness
Session S5-1

Schedule-at-a-Glance

Sunday, June 20, 2004

4:00 PM - 6:00 PM	Registration	Wells Commons Lobby
5:00 PM – 7:00 PM	Cash Bar & hors d'oeuvres	Wells Main Dining Room
6:00 PM – 7:00 PM	Dinner Buffet	Wells Main Dining Room
7:00 PM – 7:45 PM **KEYNOTE 1**	**Rosemary R. Haggett** Director, Division of Undergraduate Education National Science Foundation, Arlington, VA ***Teacher as Learner: Undergraduate Curriculum Innovation and Assessment of Student Achievement***	Wells Main Dining Room

Monday, June 21, 2004

8:00 AM – 10:30 AM	Registration	Little Hall Foyer
8:00 AM – 10:30 AM	Refreshments: coffee, danish, bagels	Little Hall Foyer
8:00 AM - 3:45 PM	Poster Session Set-Up	Wells Main Dining Room
8:30 AM – 11:45 AM RECENT FINDINGS FROM SCIENCE AND MATHEMATICS EDUCATION RESEARCH	**Session 1: Chemistry / Physics**	110 Little Hall
	Session 2: Mathematics	120 Little Hall
	Session 3: Biology / Earth Sciences	130 Little Hall
12:00 PM - 1:30 PM	Lunch – Sandwich Wrap Buffet	Wells Main Dining Room
1:30 PM – 3:30 PM	***WORKSHOPS 1-9***	For locations, see pg. 9
3:30 PM – 3:45 PM	Break	
3:45 PM – 5:15 PM	Poster Session with Reception and Cash Bar	Wells Main Dining Room
5:15 PM -	Dinner on your own	

Tuesday, June 22, 2004

8:00 AM – 10:30 AM	Registration	Little Hall Foyer
8:00 AM – 10:30 AM	Refreshments: coffee, danish, bagels	Little Hall Foyer
8:30 AM – 11:45 AM APPLICATIONS OF SCIENCE AND MATHEMATICS EDUCATION RESEARCH TO INSTRUCTION	**Session 4: Teacher Training - Professional Development**	110 Little Hall
	Session 5: Middle and Secondary Levels	120 Little Hall
	Session 6: Post-Secondary	130 Little Hall
12:00 PM - 1:30 PM	Lunch – on your own	
1:30 PM – 3:30 PM	***WORKSHOPS 10-17***	For locations, see pg. 10
3:45 PM – 5:15 PM	Round Table Discussions	Memorial Union
5:30 PM – 8:30 PM	Cash Bar	Wells Main Dining Room
6:00 PM – 7:00 PM	Dinner – Lobster, Steak, Vegetarian Banquet	Wells Main Dining Room
7:00 PM – 7:45 PM **KEYNOTE 2**	**Fred M. Goldberg** Center for Research in Mathematics and Science Education San Diego State University, San Diego, CA ***Developing Research-based Curriculum: Examples from the CIPS and PET projects***	Wells Main Dining Room

Monday, June 21st · Morning Session Overview

	(S1) Chemistry/Physics *110 Little Hall*	(S2) Mathematics *120 Little Hall*	(S3) Biology/Earth Sciences *130 Little Hall*
8:30-9:00	**Examining Student Use of a Web-enhanced DVD as an Instructional Supplement** (p. 11) ***Gabriela C. Weaver***	**Middle School Students' Production of Mathematical Justifications** (p. 13) ***Eric J. Knuth***	**Project-based science: What's the evidence that students learn?** (p. 15) ***Joseph S. Krajcik***
9:00-9:30	**Student Difficulties with Chemical Processes Involving Heat Exchange During Simple Calorimetry Experiments** (p. 11) ***Thomas J. Greenbowe***	**The Algorithm Collection Project (ACP)** (p. 13) ***Daniel C. Orey***	**A Tale of Three Theories: Development of the Geoscience Concept Test** (p. 15) ***Julie C. Libarkin***
9:30-10:00	**Investigation of Students' Reasoning in Thermodynamics and the Development of Improved Curricula** (p. 12) ***David E. Meltzer***	**College Students' Disposition Towards Mathematics** (p. 14) ***John E. Donovan II*** ***Richard Beveridge***	**Foundational Approaches in Science Teaching (FAST), An Enduring Curriculum: Its Theoretical and Pedagogical Foundations** (p. 16) ***Donald B. Young***
10:00-10:15	**Break**	**Break**	**Break**
10:15-10:45	**Measuring Modeling** (p. 12) ***Gregg Swackhamer***	**Curriculum Planning for Teacher Candidates' Learning of Science and Mathematics** (p. 14) ***Elaine V. Howes*** ***Bill Rosenthal***	**Assessment: Quantitative plus Qualitative Produces Quality** (p. 16) ***Marshall D. Sundberg***
10:45-11:15	**Which falls faster, a bowling ball or a soccer ball? – A study of a small group learning about falling objects** (p. 12) ***Fred M. Goldberg, et al.***	**Undergraduates' Beliefs about Mathematics** (p. 14) ***Pallavi Jayawant***	**The Impact of the University of Maine's NSF GK-12 Program** (p. 16) ***Deborah Perkins*** ***Darrell King***
11:15-11:45	**Learning about teaching physics: A graduate course in physics education research** (p. 13) ***John R. Thompson*** ***Michael C. Wittmann***	**Student use of integration in a physics context** (p. 15) ***Dawn C. Meredith***	**Addressing Cross-Disciplinary Barriers to the Sustainable Adoption of PLTL: Logistics and Training** (p. 17) ***Mitchell R. M. Bruce*** ***Barbara Stewart*** ***François G. Amar***

Monday, June 21st · Afternoon Workshop Schedule

***NOTE**: Although workshops do not require pre-registration, we request that you sign up for Monday and Tuesday afternoon workshops at the registration desk (Wells Lobby) when picking up your registration material. Sign up sheets are attached to conference bulletin boards.

Workshop Title	**Facilitator**	**Building & Rm.**
W1: Inquiry-based Teaching Approaches for Science (p. 24)	***Gabriela C. Weaver*** Purdue University, W. Lafayette, IN	219 Little Hall
W2: They Think What?: Capturing and Using Student Ideas in the Classroom (p. 24)	***Julie C. Libarkin*** Ohio University, Athens, OH	203 Little Hall
W3: Introduction to FAST: Teaching Science as Inquiry (p. 24)	***Donald B. Young & Richard A. Beer*** Curriculum Research and Development Group University of Hawaii at Manoa	101/102 BGSC
W4: Implementing Peer Led Team Learning (PLTL) in Calculus I at the University of Maine (p. 25)	***Jen Tyne, Paula Drewniany, Sue McGarry*** The University of Maine, Orono, ME	205 Little Hall
W5: Writing More Effective Proposals (p. 25)	***Rosemary R. Haggett*** National Science Foundation, Arlington, VA	137 Bennett Hall
W6: Constructing Ideas in Physical Science: A New Curriculum for Middle School Physical Science (p. 25)	***Fred M. Goldberg*** San Diego State University, San Diego, CA	315 Bennett Hall
W7: Using Qualitative Assessment Tools (p. 26)	***Marshall D. Sundberg*** Emporia State University, Emporia, KS	102 Bennett Hall
W8: The Integration of High School Science and Mathematics; How to Work Together to Enhance Learning in Both Disciplines (p. 26)	***Cary Kilner & Allen Griffin*** Somersworth High School Somersworth, NH	110 Little Hall
W9: With Microscopes and Moccasins: American Indian Success in Math and Science (p. 26)	***Maureen E. Smith*** The University of Maine, Orono, ME	211 Little Hall

Tuesday, June 22nd · Morning Session Overview

	(S4) Teacher Training - Professional Development	(S5) Middle and Secondary Levels	(S6) Post-Secondary
	110 Little Hall	*120 Little Hall*	*130 Little Hall*
8:30-9:00	**Cross-talk and Miscommunication in Thinking about Teaching Statistics** (p. 17) ***Patrick Thompson***	**FAST, An Enduring Curriculum: Data on Effectiveness** (p. 19) ***Donald B. Young***	**Teaching And Learning With Case Studies: What Do We Know?** (p. 21) ***Clyde F. Herreid***
9:00-9:30	**Probing for Specific Learning Ideas** (p. 17) ***Francis Eberle*** ***Page Keeley***	**Applications of Research to Improve High School Physics Classes: Physics First through AP Physics** (p. 19) ***Randal R. Harrington***	**Making Connections: A course of practical skills in physical science** (p. 21) ***Richard L. Nafshun***
9:30-10:00	**Physics for Elementary Teachers: A new curriculum** (p. 18) ***Fred M. Goldberg*, et al.**	**The Earth Science Placement Anomaly: Suggestions for Status-stepping and Strategies for Success** (p. 20) ***Paula Messina***	**Developing an Integrated Math and Science Summer Program for High School Students** (p. 22) ***William G. Ellis, Jr.***
10:00-10:15	**Break**	**Break**	**Break**
10:15-10:45	**Pre-service Mathematics Teachers' Ways of Knowing Mathematics & Philosophies of Teaching** (p. 18) ***Gideon L. Weinstein***	**A Model-Centered Approach to Earth Science Instruction** (p. 20) ***Suzi D. Shoemaker***	**Curriculum Development Cycles Using the InterChemNet System: A Tool for Action Research** (p. 22) ***François G. Amar*** ***Barbara Stewart*** ***Mitchell R.M. Bruce***
10:45-11:15	**Towards a model for thinking-focused pedagogy in the mathematics classroom** (p. 18) ***Camille Bell-Hutchinson***	**Revising the Constructing Ideas in Physical Science (CIPS) curriculum to address seemingly conflicting goals** (p. 20) ***Fred M. Goldberg***	**Conceptual learning and attitudes toward science in a general education quantum physics course** (p. 22) ***Michael C. Wittmann***
11:15-11:45	**A Model for Supporting and Maintaining the Use of Continuous Classroom Assessment** (p. 19) ***Marcia Rainford***	**Measurement: Key to Higher Math?** (p. 21) ***Christopher A. Horton***	**Outcomes Assessment in a Course Designed to Meet General Education Goals in the Area of "Population and the Environment"** (p. 23) ***Mark W. Anderson***

Tuesday, June 22nd · Afternoon Workshop Schedule

***NOTE**: Although workshops do not require pre-registration, we request that you sign up for Monday and Tuesday afternoon workshops at the registration desk (Wells Lobby) when picking up your registration material. Sign up sheets are attached to conference bulletin boards.

Workshop Title	Facilitator	Building & Rm #
W10: Using Case Studies in the Classroom (p. 27)	***Clyde F. Herreid*** University of Buffalo, Buffalo, NY	137 Bennett Hall
W11: FAST Professional Development: An Essential Component to Success (p. 27)	***Donald B. Young & Richard A. Beer*** Curriculum Research & Development Group, University of Hawaii at Manoa	101/102 BGSC
W12: Take a Walk on the Wild Side! (p. 27)	***Paula Messina*** San Jose State University, CA	203 BGSC
W13: The Colors of Light: Using Spectrometers in High School and Middle School Science Classes (p. 28)	***Barbara Stewart, Francois G. Amar, Robert Kirk & Mitchell R.M. Bruce*** The University of Maine, Orono, ME	421 Aubert Hall
W14: A Model-Centered Approach to Earth Science Instruction (p. 28)	***Suzi D. Shoemaker*** Casa Verde High School, Casa Grande, AZ	201 BGSC
W15: Supporting Students in Creating Scientific Explanations (p. 28)	***Joseph S. Krajcik*** University of Michigan, Ann Arbor, MI	102 Bennett Hall
W16: Modeling Light (p. 29)	***Gregg Swackhamer*** Glenbrook North High School, Northbrook, IL	302 Bennett Hall
W17: Warming Up the Climate for Women in Science and Mathematics Classrooms and Communities (p. 29)	***Sharon Barker & Virginia Nees-Hatlen*** The University of Maine, Orono, ME	219 Little Hall

Session Abstracts

Session 1 (S1): Chemistry / Physics
Monday, June 21, 2004 – 8:30 AM – 11:45 AM
110 Little Hall

8:30 AM

S1-1 *(Invited)* Examining Student Use of a Web-enhanced DVD as an Instructional Supplement

Gabriela C. Weaver
Department of Chemistry, Purdue University, West Lafayette, IN
gweaver@purdue.edu

We are in the midst of developing a 10-chapter DVD (Digital Versatile Disc) to be an instructional supplement to the undergraduate Physical Chemistry course. Each chapter consists of a video movie about scientific research on a topic that relates to the Physical Chemistry curriculum and also has some "real life" applicability that students can relate to. The DVD now has three modules completed and a four more in the editing phase. The completed modules have been used with students at three different institutions for the last three years.

In the assessment studies we have looked at student navigation strategies and compared them with student preferred learning styles and with performance in the course. We have also carried out pre/post-test design studies that look at student content learning gains as well as affective domain measures. This talk will briefly demonstrate and describe the features of the DVD and will then discuss the various approaches we are taking to assessing its effectiveness as a learning tool. Preliminary results from qualitative and quantitative studies will be shared.

9:00 AM

S1-2 *(Invited)* Student Difficulties with Chemical Processes Involving Heat Exchange During Simple Calorimetry Experiments

Thomas J. Greenbowe
Department of Chemistry, Iowa State University, Ames, IA
tgreenbo@iastate.edu

In collaboration with the Iowa State University Physics Education Research Group, we have investigated students' understanding of simple constant pressure calorimetry experiments involving physical processes and chemical processes. Physical processes involving calculations, for example calculating the specific heat of a metal by placing a hot piece of metal in cold water, does not pose much difficulty for students. Conceptual understanding of thermochemistry does pose a problem for students. Heat and thermal phenomena have been the subject of considerable investigation in the science education literature, but calorimetry has received little attention from science education researchers. We have developed a series of web-based computer simulations and guided inquiry tutorials to help student confront difficult topics in calorimetry. Our presentation will include a detailed analysis of student performance on solution calorimetry problems in an introductory university chemistry class for science and engineering majors. Data from written classroom exams and from several case studies will be discussed. Our findings reveal a number of learning difficulties. Students have difficulty with vocabulary terms involving thermochemistry, the law of conservation of energy, net changes in temperature of the solution (ΔT), and understanding the energy exchanged by a chemical reaction with the solution is due to bond breaking and bond forming during a chemical reaction.

9:30 AM

S1-3 *(Invited)* Investigation of Students' Reasoning in Thermodynamics and the Development of Improved Curricula

David E. Meltzer
Department of Physics and Astronomy, Iowa State University, Ames, IA
dem@iastate.edu

In collaboration with the Iowa State Chemistry Education Research Group, we have carried out a series of investigations into student learning of thermodynamics in both physical and chemical contexts. We analyzed a wide range of data including student answers on free-response exams, students' written explanations of their reasoning, and extended one-on-one interviews with students. We have found significant learning difficulties related to fundamental concepts including the first and second laws of thermodynamics, behavior of systems undergoing cyclic processes, and the origin of heat transfer in chemical reactions. We have begun development and testing of curricular materials based on this research, aimed at helping students resolve some of these learning difficulties. We are also extending both the research and the curriculum development to more advanced topics typically covered in junior- and senior-level courses, such as statistical thermodynamics and analysis of free energies.

10:15 AM

S1-4 *(Invited)* Measuring Modeling

Gregg Swackhamer
Glenbrook North High School, Northbrook, IL
pswackhamer@glenbrook.k12.il.us

"Modeling" is a set of instructional design principles that guide teachers in the construction and selection of materials and activities for students and also in their classroom practice. Because science knowledge is organized around models, physics students engage a small set of desired models through guided inquiry. Guided inquiry is a mode of instruction in which classroom materials and activities are arranged so that students will confront essential features of these models and also some of the typical student difficulties that often frustrate understanding. We will examine the effect of Modeling in physics instruction on student understanding, problem-solving, retention of understanding, and also on student beliefs about science and learning. Although there are no easy solutions to teaching and learning physics, at least in some respects Modeling has produced significant desirable results for a large fraction of teachers trained through Modeling Workshops.

10:45 AM

S1-5 Which falls faster, a bowling ball or a soccer ball? -- A study of a small group learning about falling objects

Fred M. Goldberg, Ben Williams and April Maskiewicz
Center for Research of Mathematics and Science Education, San Diego State University, San Diego, CA
fgoldberg@sciences.sdsu.edu

In the *Physics for Elementary Teachers* curriculum, college students work in small groups to develop ideas in physics. As part of a broader effort to study how students learn in a technology-rich collaborative learning environment we investigated how a group of three students came to make sense of the observation that both heavier and lighter objects can fall together (in situations where air resistance is not an important factor). We provide here preliminary findings from this study, focusing on how prior knowledge, the curriculum structure, classroom norms, and social interaction all seem to play a critical role in promoting learning within the group. Information about the PET curriculum is available at http://cpucips.sdsu.edu/web/pet.

*Supported by NSF Grant ESI-0138900.

11:15 AM

S1-6 Learning about teaching physics: A graduate course in physics education research

John R. Thompson and Michael C. Wittmann
Department of Physics and Astronomy, The University of Maine, Orono, ME
thompsonj@maine.edu

We discuss a course graduate-level course in Physics Education Research being offered as part of The University of Maine Masters of Science in Teaching (MST) program. As part of our course development, we have conducted research on graduate students' and teachers' understanding of content, pedagogy, and education research. In addition to an overview of the course, we also present evidence that students in this course can anticipate student responses indicative of common difficulties and can acquire a critical eye for assessment.

Session 2 (S2): Mathematics
Monday, June 21, 2004 – 8:30 AM to 11:45 AM
120 Little Hall

8:30 AM

S2-1 *(Invited)* Middle School Students' Production of Mathematical Justifications

Eric J. Knuth
School of Education, University of Wisconsin, Madison, WI
knuth@education.wisc.edu

In this session, results will be presented from a research project that seeks to understand the development of middle school students' competencies in justifying and proving. The primary focus of the session will be on the nature of the justifications students produce for their solutions to a variety of mathematics tasks. Data from written assessment items and interviews will be used to illustrate the results. Implications regarding instructional practices and curricular designs necessary to support the development of students' competencies in justifying and proving will also be discussed.

9:00 AM

S2-2 *(Invited)* The Algorithm Collection Project (ACP)

Daniel C. Orey
The Department of Teacher Education, California State University, Sacramento, CA
orey@csus.edu

The Algorithm Collection Project is to collect and disseminate alternative algorithms in mathematical problem solving. Participants gather and study the four basic operations (addition, subtraction, multiplication and division) in arithmetic. We are especially interested in the unique links between language and the algorithms we use to solve problems. Much of the data collected has been gleaned from interviews from newly arrived immigrant adolescent high school students to Northern California. We are extremely interested in learning how students may have learned and how students do:

- The basic arithmetic operations of addition, subtraction, multiplication and division
- Memorization of basic facts
- Algebra
- Geometry

9:30 AM

S2-3 College Students' Disposition Towards Mathematics

John E. Donovan II and Richard Beveridge
Department of Mathematics and Statistics, The University of Maine, Orono, ME
John.Donovan@umit.maine.edu

In order to measure college students' disposition towards mathematics we are working to develop a questionnaire, the Mathematical Disposition Survey. Our survey is based upon the Maryland Physics Expectation Survey (MPEX). In this presentation we will discuss findings from a pilot survey with our instrument conducted in Spring 2004 which includes pre and post measures from n = 585 students (there were 585 respondents in the pretest, post test data is currently being evaluated). An authentic means to evaluate this data will be introduced, the Mean Distance from Optimal. We will also discuss the results from an open-ended response item where respondents gave one word to describe their feelings about mathematics and elaborated on their choice.

10:15 AM

S2-4 Curriculum Planning for Teacher Candidates' Learning of Science and Mathematics

Elaine V. Howes
College of Education, University of South Florida
Tampa, FL
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and

Bill Rosenthal
Hunter College of the City University of New York
New York, NY
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Elementary science and mathematics teacher educators overwhelmingly consider the enhancement of teacher candidates' content knowledge to be a significant aspect of our jobs. No research-based consensus yet exists on effective approaches to this work; instructional experiments abound. This presentation addresses our experimentation with employing curriculum planning in mathematics and science methods classes as a vehicle for developing deep, wide, and broad content knowledge.

In particular, we will discuss a troubling paradox at this heart of this endeavor. K-6 teaching candidates consistently maintain that their greatest fear in teaching is being asked a question they cannot answer. Our (distinct yet similar) curriculum-planning approaches are largely inspired by this fear. It is reasonable to hypothesize that developing the material to be taught in great detail and depth renders teachers both better prepared to address children's questions and more confident of their readiness. Nevertheless, we perceive our candidates to be largely bewildered by and resistant to a content-knowledge-based process for curriculum planning.

Our presentation will manifest empirical evidence of our struggles with this paradox. We will also draw on the research literature (e.g., Sosniak, 1999) to contextualize and further problematize the issue of curriculum planning as a venue for learning science and mathematics.

10:45 AM

S2-5 Undergraduates' Beliefs about Mathematics

Pallavi Jayawant
Department of Mathematics, Bates College, Lewiston, ME
Department of Mathematics, University of Arizona, Tucson, AZ
jayawant@math.arizona.edu

Beliefs play an important role in mathematics learning and teaching. Different groups of students have varied beliefs about mathematics and its learning and teaching. For example, the undergraduates in a college algebra course may have beliefs that positively or negatively impact their learning in the course. What beliefs do they come in with and what beliefs would we like to change during the course and how can we change them? The researchers in the Integrating Mathematics and Pedagogy (IMAP) project have tried to answer such questions for prospective elementary school teachers (Phillip, Clement, Thanheiser, Schappelle, Sowder). They have studied the effects of integrating children's thinking into the mathematics content courses for prospective elementary school teachers. I will use some of the guiding principles of IMAP to discuss possible applications to research in undergraduate math education.

11:15 AM

S2-6 Student use of integration in a physics context

Dawn C. Meredith
Department of Physics, University of New Hampshire, Durham, NH
dawn.meredith@unh.edu

We presented students in the introductory calculus-based physics course with physics problems that required calculus in the solution. However, the need for calculus was not explicitly stated. We interpret these interviews using the frameworks of Sfard (mathematical conceptions as operational or structural) and Sherin (symbolic forms). We give evidence of a common progression in understanding of integrals, and note that the understanding of limit and of the integral as a sum may be linked. We also share some practical ideas for teaching calculus in a physics context.

Session 3 (S3): Biology / Earth Sciences
Monday, June 21, 2004 – 8:30 AM to 11:45 AM
130 Little Hall

8:30 AM

S3-1 ***(Invited)*** **Project-based science: What's the evidence that students learn?**

Joseph S. Krajcik
School of Education, University of Michigan, Ann Arbor, MI
krajcik@umich.edu

Teaching science through a project-based approach allows students opportunities to explore real world problems, make connections between various ideas that they might not have otherwise made, participate in a variety of scientific practices, and see how the principles and concepts of science can explain important and various phenomena in their world. Project-based science also provides teachers with one way to meet the call of the National Science Education Standards that states that inquiry should be the primary mode of instruction for teaching science. Yet, teaching science through this approach brings many challenges even for the most experienced science teachers. Although using a project-based approach appears to provide many opportunities for students as well as for teachers, we need to weigh the benefits and challenges and ask: What evidence exists that teaching science in a project-based approach helps students meet important learning goals? How does the achievement of students who learn science in a project-based environment compare to those who don’t learn science in this type of environment? In this talk, I will explain the features project-based science, discuss the advantages and disadvantages of teaching in a project-based approach, and examine the evidence for and against students learning science in this type of environment.

9:00 AM

S3-2 ***(Invited)*** **A Tale of Three Theories: Development of the Geoscience Concept Test**

Julie C. Libarkin
Department of Geological Sciences, Ohio University, Athens, OH
Libarkin@Ohio.edu

Over 5,000 students from more than fifty universities and colleges nationwide participated in a study aimed at developing an assessment instrument for entry-level geo-science courses. Short, open-ended questionnaires from 1000 students and interviews with 200 students provided insight into ideas about the Earth held by entry-level students, and these ideas drove the development of test questions and answers. The test was created in two phases: a small, 29-item test was piloted in Fall 2002 and evaluated using item response theory and qualitative validation techniques. Based upon the success of this initial testing, a second set of 45 questions was created for piloting in Fall 2003. Our experiences with the Geo-science Concept Test indicate that 1) assessment questions created in direct response to student interviews are particularly useful in large-scale testing of student ideas; 2) a variety of qualitative and quantitative measures should be used when creating assessment instruments to ensure validity of the test design and application; and 3) many alternative ideas about the Earth are difficult to modify, as evidenced by small change between pre- and post-test scores nationwide.

9:30 AM

S3-3 ***(Invited)*** **Foundational Approaches in Science Teaching (FAST), An Enduring Curriculum: Its Theoretical and Pedagogical Foundations**

Donald B. Young
Curriculum Research & Development Group
College of Education, University of Hawaii at Manoa
young@hawaii.edu

Conceptualization and development of the three-year sequential middle-school Foundational Approaches in Science Teaching (FAST) program was initiated at the Curriculum Research & Development Group (CRDG) of the University of Hawaii in 1966. FAST is rooted in Herbert Spencer's instructional hypothesis of knowledge organization through recapitulation and the constructivist assumptions of John Dewey. Using these insights, a sequential set of laboratory and field investigations were invented, tested, and modified in the grade 6-9 classes of University Laboratory School and then further tested beginning in 1970 in pilot schools throughout Hawaii. These investigations put students in the role of researchers constructing anew the foundational concepts and inquiry skills of modern science. After twelve years of research-centered program adjustments, the program was introduced to schools on the U.S. Mainland in 1978. Thirty eight years after inception, FAST remains a viable program undergoing continuing scrutiny, dissemination, research, and assessment and addresses the concerns and recommendations of the National Science Education Standards and international testing. FAST's theoretical and pedagogical foundations, its teacher in-service support system, and assessments of program effectiveness will be presented.

10:15 AM

S3-4 ***(Invited)*** **Assessment: Quantitative plus Qualitative produces Quality**

Marshall D. Sundberg
Department of Biological Sciences, Emporia State University, Emporia, KS
sundberm@esumail.emporia.edu

Qualitative assessment techniques are often under-utilized by math and science teachers because they are perceived as “softer” than quantitative instruments. Because the data generated is subjective, it is not amenable to statistical testing and is thus considered to be less reliable and less meaningful. In fact, qualitative assessment can provide a much richer understanding of the learning that actually occurs in the classroom. A combination of the “broad brushstrokes,” provided by quantitative instruments, and the “finer detailing” provided by qualitative tools allows the instructor to more critically evaluate the efficacy of instruction and focus more sharply on areas of difficulty. Examples will be provided of how interviews, journal writing, minute papers, and concept mapping can effectively be combined with content pre/post-tests to improve student understanding of difficult and frequently misunderstood concepts involving cell biology, plants, and evolution. Some advantages and disadvantages of each instrument will also be discussed.

10:45 AM

S3-5 The impact of the University of Maine's NSF GK-12 Program

Deborah Perkins
The University of Maine, Orono, ME
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and

Darrell King, Brewer High School, Brewer, ME
Susan Brawley, Barbara Cole, Susan Hunter, Steve Norton
The University of Maine, Orono, ME
Ruey Yehle, Hampden Academy, Hampden, ME

The National Science Foundation (NSF) GK-12 program at Maine (1999-2005) partners excellent graduate students (and 1-2 undergraduates) in science, engineering, and mathematics with excellent teachers in the local grade 3-11 classrooms for approximately 8 hours per week, over a 9-month period. The goals are to promote (1) higher achievement in Maine's Learning Results, (2) better communication and teaching skills, (3) professional development, (4) enriched science for students, (5) effective role models, (6) stronger linkage among science faculty and K-12 districts.

Fellow's major advisors indicate improvement in communication skills and organizational ability, and an increased awareness of the importance of teaching science well. Teachers have reported acquiring significant scientific understanding, greater confidence, and increased self-esteem - the latter partly from attendance at professional meetings. Inquiry-based instruction has increased. Impacts on students include increased utilization of previously unavailable research equipment, increased understanding of and experience in the scientific method, and higher aspirations. Field trips to do natural science, and visits to the research activities at the University have broadened students and teachers awareness of the University's activities. Awareness of the importance of K-12 science education has been enhanced for participating faculty.

11:15 AM

S3-6 Addressing Cross-Disciplinary Barriers to the Sustainable Adoption of Peer Led Team Learning: Logistics and Training

Mitchell R.M. Bruce, Barbara Stewart, and François G. Amar
Department of Chemistry, The University of Maine, Orono, ME
Mbruce@maine.edu

We discuss the effect that the introduction of Peer Led Team Learning (PLTL) has had on the UMaine general chemistry program. Data indicates that student grades and retention rates have improved. We consider certain obstacles to sustainable adoption of PLTL that are faced across institutions and disciplines: a) managing a large program and supervising leaders and b) providing initial and ongoing training for leaders. The introduction of technology (www.interchemnet.com) to facilitate the management and assessment of PLTL appears to be very beneficial for use with large numbers of students. Plans to develop leader training curriculum materials to help with the most pivotal and faculty labor-intensive part of the PLTL program will be presented.

Session 4 (S4): Teacher Training/Professional Development
Tuesday, June 22, 2004 – 8:30 AM – 11:45 AM
110 Little Hall

8:30 AM

S4-1 *(Invited)* Cross-talk and Miscommunication in Thinking about Teaching Statistics

Patrick Thompson
Department of Teaching and Learning, Vanderbilt University, Nashville, TN
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Increased attention to statistics and data modeling is a hallmark of mathematics education reform. I discuss results from a teaching experiment with eight high school statistics teachers that point to meanings and presumptions that are often held tacitly that nevertheless reveal themselves in teachers' actions in ways that confound and confuse already complicated issues.

9:00 AM

S4-2 Probing for Specific Learning Ideas

Francis Eberle
Executive Director
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and

Page Keeley
Senior Program Director
Maine Mathematics & Science Alliance
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Science instructors at all levels make determinations of the success students are making in their class. This often lacks the scrutiny resulting in informing the instructor as to why students may be answering questions in a particular way. Are students answering because they misunderstand the question, or is it that they lack the fundamental knowledge to answer it correctly? Collaborative Inquiry into Examining Student Thinking is a process developed to use student work for learning about why students answer the way they do, and to improve the subsequent instruction. The process includes reflection on content, standards, research on student ideas, alternative conceptions, and the coherence and sequence of science ideas. Preliminary results from teachers who participate in this process include; increasing their content knowledge and grades K-12 topic coherency, identifying alternative conceptions, difficulties and developmental considerations of specific science ideas, and identifying levels of simplicity and sophistication of science ideas. The change in teachers' understanding often reveals that students are frequently missing the fundamental knowledge and that is why they have difficulty in science. Student work across grade levels will illustrate gaps, but also provide the basis for participation in the Collaborative Inquiry into Examining Student Thinking process.

9:30 AM

S4-3 Physics for Elementary Teachers: A new curriculum

Fred Goldberg
Center for Research of Mathematics and Science Education
San Diego State University, San Diego, CA
fgoldberg@sciences.sdsu.edu

and

Steve Robinson, Tennessee Technological University
Valerie Otero, University of Colorado at Boulder

With support from NSF we have developed a one-semester research-based Physics for Elementary Teachers (PET) course that focuses on achieving four main goals: physics content, nature of science, elementary students' ideas, and learning about learning. Students develop their ideas in a technology-rich collaborative learning environment. In this presentation I will briefly summarize some interesting aspects of the curriculum: promoting conceptual learning both within class and with web-based tools; and having PET students observe video from elementary classrooms to analyze elementary children's thinking and to make connections with their own learning in the PET classroom. During the 2003-2004 academic year the curriculum has been piloted at six Universities, and we expect over 25 Universities and two-year colleges to be involved in a larger field-test during 2004-2005. Information about the PET curriculum is available at http://cpucips.sdsu.edu/web/pet.

*Supported by NSF Grant ESI-0138900.

10:15 AM

S4-4 Pre-service Mathematics Teachers' Ways of Knowing Mathematics & Philosophies of Teaching

Gideon L. Weinstein
Department of Mathematical Sciences, Montclair State University, Montclair, NJ
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It is often argued that many secondary mathematics teachers lack the in-depth subject matter knowledge required to successfully implement a meaningful and high-quality mathematics curriculum. A teacher's mathematical knowledge must be deep and conceptual in order to help students achieve high-quality mathematical understanding, and an unsophisticated understanding of mathematics leads to uninspired teaching. Therefore, it is important to gain a clear understanding of how preservice and practicing teachers relate to the content material and how that relationship influences their teaching philosophies and practices. This presentation reports two case studies of pre-service teachers within a larger longitudinal project tracking intellectual development in mathematics and philosophies of teaching in prospective and practicing teachers. Theories of adult intellectual development provide stage-by-stage developmental frameworks that include descriptions of the generation and verification of general knowledge. I reframed these theories to address "ways of knowing mathematics" – developmental stages for learning and verifying mathematics. I use Ernest (1993) to provide the theoretical underpinning for deep and thorough descriptions of philosophies of mathematics education. In less advanced teachers, absolutist views of knowledge dominate and teaching is seen as an authority-centered activity. More advanced teachers are more effective and student-centered in their teaching and think of knowledge as contextual and socially constructed.

10:45 AM

S4-5 Towards a model for thinking-focused pedagogy in the mathematics classroom

Camille Bell-Hutchinson
School of Education, The University of the West Indies, Mona, Jamaica
camille.bellhutchinson@uwimona.edu.jm

Despite the large body of literature which highlights the negative impact of teaching by rote on the development of mathematical thinking and mathematical understanding, this kind of pedagogy continues to be the hallmark of many mathematics classrooms both locally and internationally. This paper draws upon emerging data from research conducted in two secondary schools in Jamaica and highlights aspects of the pedagogy of two teachers who implemented a thinking-focused intervention in their mathematics classrooms over a period of one year. The paper gives insight into the issues surrounding their intervention and discusses aspects of the emerging data which points to a model for thinking-focused pedagogy in the mathematics classroom.

11:15 AM

S4-6 A Model for Supporting and Maintaining the Use of Continuous Classroom Assessment

Marcia Rainford
School of Education, The University of the West Indies, Mona, Jamaica
marcia.rainford@uwimona.edu.jm

The use of continuous assessment to facilitate learning is supported by a constructivist approach to teaching and learning. Teachers are often faced with various dilemmas which interfere with their attempt to use continuous classroom assessment on a sustained basis to improve learning. Various aspects of schooling such as students' abilities, the need to participate in high stakes examinations, the teacher's professional competence and school-related factors such as the physical and administrative components, mitigate against the use of classroom assessment in a coordinated and sustained way. The paper proposes a model for implementing the use of classroom assessment that is grounded in classroom practice. The model involves collaborations among the teachers, school administration and students. The paper outlines the process that led to the development of the model and explores the implications for its implementation.

Session 5 (S5): Middle and Secondary Levels
Tuesday, June 22, 2004 – 8:30 AM – 11:45 AM
120 Little Hall

8:30 AM

S5-1 *(Invited)* FAST, An Enduring Curriculum: Data on Effectiveness

Donald B. Young
Curriculum Research & Development Group
College of Education, University of Hawaii at Manoa, Honolulu, HI
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Following ten-plus years of initial development, testing, and revision, sufficient data had been accumulated on the impact of FAST on student learning to generate interest outside Hawaii. Project developers entered into long-term systematic data collection on effectiveness with both students and teachers. External reviews of the quality of the instructional materials, use of appropriate evaluation designs, and examination of the educational significance of outcomes include the U.S. Department of Education's Joint Dissemination Review Panel and the Program Effectiveness Panel, the National Staff Development Council's What Works in the Middle Grades, and the U.S. Department of Education's Expert Panel on Mathematics and Science Education. As a result of the Expert Panel review, FAST was identified as one of only two programs nationally to be named exemplary based on sustained effects on learning over multiple years in multiple sites. This session will highlight some of these findings.

9:00 AM

S5-2 *(Invited)* Applications of Research to Improve High School Physics Classes: Physics First through AP Physics

Randal R. Harrington
The Blake School, Minneapolis, MN
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I will describe the development and discuss issues of implementation of a high school physics program that has made use of multiple research-based curricula that includes aspects of Modeling, Physics by Inquiry, CPU, Tutorials in Introductory Physics, and on-line Web based problem solving (WebAssign and Cybertutor). The program starts with Physics First in 9th grade, and includes numerous electives including modern physics, astronomy, electronics, and AP Physics.

9:30 AM

S5-3 ***(Invited)*** **The Earth Science Placement Anomaly: Suggestions for Status-stepping and Strategies for Success**

Paula Messina
Department of Geology, San Jose State University, San Jose, CA
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The Earth Sciences have traditionally been viewed as having less "academic prestige" than other science curricula. This perception may (1) depress K-16 enrollments in Earth Science courses, (2) increase placement of lower-performing students in Earth Science courses, and (3) relegate Earth Science instruction to under-qualified educators. These factors may be contributing to a self-fulfilling situation. An Earth Systems course at San José State University has identified the difficulties of, and deficiencies in, a standard high school Earth Science curriculum. Results from this course suggest that one way to enhance student Earth Science understanding is to restructure secondary science curricula to make Earth Science the capstone course. This is aligned with research demonstrating that reversing the traditional science course sequence (by offering Physics in the ninth grade) improves student success in subsequent science courses. Addressing the problem at the college level involves (1) developing Earth Systems courses that account for differing student backgrounds and utilize real-world tasks and hands-on learning, and (2) offering well-crafted workshops for pre-service and in-service Earth Science teachers.

10:15 AM

S5-4 ***(Invited)*** **A Model-Centered Approach to Earth Science Instruction**

Suzi D. Shoemaker
Casa Verde High School, Casa Verde, AZ
Sdshoe@c2i2.com

This talk will describe an effort to create innovative curriculum materials for the instruction of high school Earth Science. In 1998, I received training in how to teach physics using the Modeling Approach to Physics, and became convinced that this pedagogical approach can be more effective than the traditional use of textbooks, lectures, note-taking, memorization, and laboratories, etc. Generally, a Models Centered Approach to instruction requires that curricula: be activity based; concept rich; and nomenclature poor, with a well-defined concept flow. Over the past two summers I have worked on developing these materials. The products of this effort represent a concept flow using the rock and water cycles as a format, and curriculum materials covering the beginning units: maps, plate tectonics, earthquakes, and volcanic activity.

These curriculum materials are early in their development, but were piloted this spring at Casa Verde High School in Casa Grande, Arizona. Subsequent efforts will include the three rock types and their formation, as well as the beginnings of the water cycle topics. Questions have been raised about the inclusion of Astronomy and Paleontology, but no conclusion has been reached on how to best include (or not include) these topics.

10:45 AM

S5-5 Revising the Constructing Ideas in Physical Science (CIPS) curriculum to address seemingly conflicting goals*

Fred Goldberg
Center for Research in Mathematics and Science Education
San Diego State University, San Diego, CA
fgoldberg@sciences.sdsu.edu

CIPS is an NSF-funded curriculum originally designed to help students develop a deep conceptual understanding of the national content and nature of science benchmarks and standards for middle school physical science.** The No Child Left Behind legislation and the plans of states to mandate assessments based on their own set of science standards have led us to expand our original design goal. We are adding to the core CIPS curriculum additional activities that will help students learn the content included in those state standards that do not match the national ones. In this talk I will describe the challenges of trying to meet the dual goals of promoting both understanding and coverage, and will indicate how the CIPS staff has decided to meet those challenges. Information about the CIPS curriculum is at http://cpucips.sdsu.edu/web/CIPS.

*Supported by NSF Grants ESI- 9812299 and ESI- 0138900
**AAAS Project 2061 Benchmarks for Scientific Literacy (1993, Oxford Press) and the National Science Education Standards (1995, National Academy of Sciences)

11:15 AM

S5-6 Measurement: Key to Higher Math?

Christopher A. Horton
High School of Commerce, Springfield, MA
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I am teaching Algebra I Support for the second year in an inner-city school, to five sections of students selected for their deficiencies in mathematics. On a pre-test, none of these students was able to interpret or perform operations using fractions, ratios or proportions. Among the topics these students have had extreme difficulty with are: setting up a number line, counting distances along it, including and counting zero, performing operations with signed numbers, interpreting subtraction as "finding the difference", the concepts of slope of a line and rate, and solving an equation using division. Not one started with the ability to read a ruler calibrated in English measure. The students persistently focused on and counted boundaries of intervals, rather than the intervals themselves.

I will argue that most or all of these phenomena have at their root a lack of understanding of using numbers to represent intervals in time, distance or other arbitrarily segmented phenomena. I will propose a research project to demonstrate that this is so, that an effective pedagogical approach can be built around the teaching of measurement of physical phenomena, as developed by Jerome Epstein, and that this produces breakthroughs in understanding algebra.

Session 6 (S6): Post-Secondary
Tuesday, June 22, 2004 – 8:30 AM – 11:45 AM
130 Little Hall

8:30 AM

S6-1 *(Invited)* Teaching And Learning With Case Studies: What Do We Know?

Clyde F. Herreid
National Center for Case Study Teaching in Science
University at Buffalo, State University of New York, Buffalo, NY
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Case study teaching is a recent innovation in basic science classrooms. Techniques of instruction within this genre vary enormously but their impact on student learning has not been well evaluated. Nor has the case study method in business and law been seriously evaluated even though the method has been in use for a hundred years. Nonetheless, the few studies that have been designed indicate that the method is highly successful. I will summarize the data from the literature, present our results from a survey of 150 case teachers, and outline our plans for and assessment program that is supported by a National Science Grant.

9:00 AM

S6-2 Making Connections: A course of practical skills in physical science

Richard L. Nafshun
Department of Chemistry, Oregon State University, Corvallis, OR
nafshunr@chem.orst.edu

Many students reach their first college-level physical science course lacking robust conceptual understandings and the ability to use their mathematical knowledge flexibly. Mathematics and Science Education research confirms the existence of a “translation” or “transfer” difficulty among students—that students may have successfully completed mathematics courses listed as prerequisites to physical science courses, but they face real challenges when asked to transfer this knowledge to another field. The difficulty lies in extending these skills to situations in which the mathematical variables represent attributes of the physical world and in which mathematical equations represent relationships amongst those physical attributes. In winter term 2004, Oregon State University offered a new one-credit, optional course for freshman that required students explicitly to articulate simple physical relationships using their mathematics skills. The class was developed jointly by faculty and graduate students from Chemistry, Mathematics, Physics and Engineering. The content of the course included transitioning among multiple representations (graphs, equations, and words) for physical systems, and working with mathematics as it represents the behavior of real physical objects instead of straightforward symbol manipulation. Formal external evaluation of this pilot class will be described.

9:30 AM

S6-3 Developing an Integrated Math and Science Summer Program for High School Students

William G. Ellis, Jr.
Upward Bound and the School of Marine Sciences, The University of Maine, Orono, ME
wge@umit.maine.edu

Over a 12-year period, our Upward Bound Math-Science program at the University of Maine has evolved from a traditional math and science curriculum to an integrated curriculum. We currently use group and individual research projects as vehicles to deliver a basic understanding of how research is performed in various fields. We provide tutorials in areas that are needed to successfully complete the research projects such as statistics, graphing, and presentation methods. The student research is showcased in our in-house journal and a poster session modeled after a professional science meeting.

We have been fortunate to have several UMaine faculty members as full-time summer staff who are responsible for the academic structure of the group project and the tutorials. For the individual research projects, we work with the four faculty members plus other faculty and graduate students on the UMaine campus. In addition, we have worked with medical doctors, veterinarians, and other scientists off campus.

This presentation will discuss what has worked for us and which ideas we consider critical to the success of our model. We will also discuss what has not worked from our perspective.

10:15 AM

S6-4 Curriculum Development Cycles Using the InterChemNet System: A Tool for Action Research

François G. Amar, Barbara Stewart, and Mitchell R.M. Bruce
Department of Chemistry, The University of Maine, Orono, ME
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InterChemNet (ICN) is a Web-based management program designed to foster active learning in the laboratory. The system allows students choices of discovery-based experiments, a host of background information, and quick and easy access to UV-visible and FTIR spectrometers. The system creates *individualized pathways* for students by allowing instructors to present a hierarchy of lab choices and assignments in a given week. An evaluation module is integrated into the system to provide immediate feedback for students and evaluation data for instructors. Because assessment is integrated with curriculum delivery, ICN facilitates the introduction of chemical education research into existing courses based on local curricular goals. By making it easy for instructors to analyze learning outcomes for the course, ICN can be used to promote a systematic and evidence-based curriculum development cycle.

10:45 AM

S6-5 Conceptual learning and attitudes toward science in a general education quantum physics course

Michael C. Wittmann
Department of Physics and Astronomy, The University of Maine, Orono, ME
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Members of the University of Maine Physics Education Research Laboratory are bringing modern physics ideas into a general education course for non-science-major students. We have modified materials from proven curricula to match student needs and skills. Students develop basic concepts of quantum physics with an emphasis on observations and building analogies to everyday events and simple intuitive physics situations. We have studied both students' attitudes toward science and students' conceptual reasoning skills. Research methods include the analysis of data from the MPEX2 and written pre- and post-test responses. Students do well at learning some things (such as the nature of knowledge in quantum physics), while having difficulties understanding concepts such energy quantization and quantum tunneling.

11:15 AM

S6-6 Outcomes Assessment in a Course Designed to Meet General Education Goals in the Area of "Population and the Environment"

Mark W. Anderson
Department of Resource Economics and Policy, The University of Maine, Orono, ME
Mark.Anderson@umit.maine.edu

Regional accreditation bodies in higher education ask member institutions to establish general education requirements for undergraduates and to assess the learning outcomes resulting from those general education requirements. As part of its General Education requirements, the University of Maine established goals for learning in the area of "population and the environment". An experiment in assessing learning outcomes for students in a course designed to address this area was conducted to measure content learning outcomes and changes in students' attitudes. Twenty-five content questions and 10 attitudinal questions were asked each of three semesters in a class of approximately 125 students. Students completed the instrument on the first day of class and the last day of class each semester, affording the opportunity to observe changes both within a single class (measuring learning?) and in the same class from semester to semester (measuring response to changes in pedagogy?). Measures of content learning outcomes were used to design changes in both course content and pedagogy. Measures of attitudinal changes provide important, if ethically challenging, information to the instructor on the affective impacts of the course.

Workshop Abstracts

Monday Afternoon Workshops
1:30 PM – 3:30 PM

Workshop 1 (W1)
Inquiry-based Teaching Approaches for Science

Gabriela C. Weaver
Department of Chemistry, Purdue University, West Lafayette, IN

Location: 219 Little Hall

Inquiry-methods are widely discussed in the research literature as a favored approach for classroom teaching in science. But what IS "inquiry-based" teaching? And does a teacher go about using it? In this workshop we will first discuss and explore the characteristics of inquiry for teaching and learning. Participants will then talk about adapting a lesson from a "traditional" laboratory experiment into an "inquiry-based" lesson. If possible, participants are asked to bring a copy of a traditional laboratory lesson that they would like to adapt to inquiry-based methods.

Workshop 2 (W2)
They Think What?: Capturing and Using Student Ideas in the Classroom

Julie C. Libarkin
Department of Geological Sciences, Ohio University, Athens, OH

Location: 203 Little Hall

This workshop will provide a hands-on opportunity to discuss and practice simple techniques that faculty can use to uncover student ideas in classroom settings. Modern conceptual change theory suggests that students will only be able to adopt scientific models if previously held ideas are challenged and found lacking. Unfortunately, challenging student ideas is difficult in many sciences, particularly where phenomena, such as geologic time or DNA, are not directly observable. Most instruction at the college level, whether lecture or inquiry-based, is focused on conveying scientific models to students. However, this workshop suggests that students should be encouraged to openly discuss or share pre-existing ideas prior to exposure to more scientific concepts. This sharing of ideas allows 1) *students* to recognize disparities between previous experiences or instruction and ongoing instruction; and 2) *faculty* to recognize the broad range of ideas that students bring to any classroom encounter. Personal experiences with college level Introduction to Geology courses will be used to exemplify techniques for collecting and using student ideas, and participants will be encouraged to practice these techniques during the workshop.

Workshop 3 (W3)
Introduction to FAST: Teaching Science as Inquiry

Donald B. Young
Curriculum Research & Development Group
University of Hawaii at Manoa, Honolulu, HI

and

Richard A. Beer
Middle School of the Kennebunks
Curriculum Research & Development Group
University of Hawaii at Manoa, Honolulu, HI

Location: 101/102 Bryand Global Science Center

This workshop will engage participants in an introductory sequence of investigations from the first course in the FAST sequence, *The Local Environment*. The sequence exemplifies the FAST approach to inquiry in which students describe phenomena, generate hypotheses and data, seek patterns and relationships, and create generalizations. Co-presented by a FAST developer and an experienced FAST teacher and certified trainer.

Workshop 4 (W4)

Implementing Peer Led Team Learning (PLTL) in Calculus I at the University of Maine

Jen Tyne, Paula Drewniany and Sue McGarry
Department of Mathematics and Statistics, The University of Maine, Orono, ME

Location: 205 Little Hall

The Math Department at the University of Maine began implementing Peer Led Team Learning (PLTL) in two sections of MAT126 (Calculus I) in Spring 2004. The PLTL Workshop model provides an active learning experience for students by engaging teams of eight to ten students in challenging calculus workshops, guided by a peer leader. This two-hour presentation will cover the challenges and rewards of our efforts. We will discuss our PLTL program, present some of our developed workshops, and highlight some of our evaluation results. Participants, guided by a leader, will also experience first-hand one of our workshops.

Workshop 5 (W5)

Writing More Effective Proposals

Rosemary R. Haggett
National Science Foundation, Arlington, VA

Location: 137 Bennett Hall

You have a good idea for a science, technology, engineering and mathematics (STEM) education proposal, but most proposals start with a good idea. How do you go beyond a good idea? What can you do to maximize the likelihood that your proposal will be funded? This “working” workshop will focus on areas for enhancing a proposal that contains a good idea. Engaging in team activities, workshop participants will identify, consider and discuss ideas about how to write a more effective proposal. Topics to be considered include: framing the objective to broaden its impact, relating the idea to a larger context, developing an effective evaluation plan, and designing active, aggressive dissemination strategies. After the workshop, participants should be able to identify areas where good STEM education proposals can be improved and suggestions for improvement for each area.

Workshop 6 (W6)

Constructing Ideas in Physical Science: A New Curriculum for Middle School Physical Science*

Fred M. Goldberg
Center for Research of Mathematics and Science Education, San Diego State University, San Diego, CA

Location: 315 Bennett Hall

CIPS is a coherent, hierarchically constructed middle school physical science curriculum with two content goals: helping students develop a deep conceptual understanding of the content and nature of science National Science Education Standards and Project 2061 Benchmarks; and helping to familiarize students with many additional state physical science content standards. The CIPS pedagogy was guided by research on student learning of science. This workshop will introduce participants to the content and pedagogy of CIPS. We will work through a sample activity or two to get a flavor for the pedagogy, view and discuss videos from CIPS classrooms, examine the robust on-line CIPS teacher guide, and discuss CIPS professional development resources.

*CIPS is supported by NSF grants ESI-9812299 and ESI-0138900

Workshop 7 (W7)

Using Qualitative Assessment Tools

Marshall D. Sundberg
Department of Biological Sciences, Emporia State University, Emporia, KS

Location: 102 Bennett Hall

Qualitative assessment tools are often under-utilized by math and science teachers. This workshop will provide hands-on application of several of these, including interviews, minute papers, and concept mapping. Participants will work both in large groups and smaller teams as each tool is introduced and applied to sample classroom situations.

Workshop 8 (W8)

The Integration of High School Science and Mathematics; How to Work Together to Enhance Learning in Both Disciplines

Cary Kilner and Allen Griffin
Somersworth High School, Somersworth, NH

Location: 110 Little Hall

Much informal discussion over the years has led us to isolate many common mathematical difficulties students have in their science courses. Examining our high school practice we have discovered several unacknowledged barriers to addressing these, such as lack of congruity, poor timing, contradictory methodologies, conflicting use of terms, and a lack of understanding how and what each other is actually teaching.

We have collected much relevant science and math education research we can share. We will also give anecdotal vignettes and examples, and discuss some common techniques such as the use of significant figures and scientific notation, the consideration of error, algebraic rearrangement, unit analysis, and scientific graphing.

We will also provide specific problem-solving situations involving proportionality such as mixture problems, rate problems, and others related to specific functions, like density and specific heat capacity.

Workshop 9 (W9)

With Microscopes and Moccasins: American Indian Success in Math and Science

Maureen E. Smith
Oneida, Director of Native American Studies
The University of Maine, Orono, ME

Location: 211 Little Hall

This session will assist in providing new and additional education content and instructional strategies to educators by responding to the need for Indian appropriate math and science teaching techniques, on and off reservation schools. Teachers attending the session will receive information and materials that will facilitate in disseminating the strategies and techniques to specifically benefit Native American students in their classrooms. Additionally, we will briefly touch on issues pertaining to LD 291, an act to require the teaching of Maine Native American history and culture effective September, 2004, and how Maine math and science teachers can assist in this legislation.

Tuesday Afternoon Workshops
1:30 PM – 3:30 PM

Workshop 10 (W10)
Using Case Studies in the Classroom

Clyde F. Herreid
Director of the National Center for Case Study Teaching in Science
University at Buffalo, State University of New York, Buffalo, NY

Location: 137 Bennett Hall

Case studies are "stories with an educational message." There are more than a dozen ways to tell the story—by lecture, by discussion (public hearing, debate, Socratic cross examination, role playing, etc.) or by using small groups. The method that is favored by most science instructors is the Interrupted Case Method where the story is given piece meal to the students and they grapple with the problems as they emerge. This approach is not only engaging and challenging but mimics the way that real science is conducted. In this interactive workshop the participants will experience the method first as students and then as a faculty member debriefing the process.

Workshop 11 (W11)
FAST Professional Development: An Essential Component to Success

Donald B. Young
Curriculum Research & Development Group
University of Hawaii at Manoa, Honolulu, HI

and

Richard A. Beer
Middle School of the Kennebunks and
Curriculum Research & Development Group
University of Hawaii at Manoa, Honolulu, HI

Location: 101/102 Bryand Global Science Center

From its beginning, FAST developers have required teachers to participate in intensive professional development prior to use in their classrooms. This workshop will discuss the history of FAST professional development revolution, what was designed, what worked and what didn't; conditions for successful implementation and barriers to scaling up. Data will be presented on effectiveness of professional development in changing teaching strategies. Participants will preview the latest professional development electronic enhancement now in beta-test form. Co-presented by a FAST developer and an experienced FAST teacher and certified trainer.

Workshop 12 (W12)
Take a Walk on the Wild Side!

Paula Messina
Department of Geology, San Jose State University, San Jose, CA

Location: 203 Bryand Global Science Center

Three high-interest activities using biogenic and physical traces in the recreation of past events have been constructed to help develop student understanding of the *process* of science without sacrificing substantive geoscience content. Adaptations of human footprints, dinosaur trackways, and sliding rock trails can be utilized in a variety of K-12 grade levels, with multi-disciplinary scope. In each module, which will be demonstrated in this hands-on workshop, students are encouraged to act as detectives by gathering information, collaborating with peers, and reaching logical conclusions. Students are therefore charged with observing, assimilating, communicating, and formulating hypotheses. Hence the process of science is *experienced* while students explore archaeological, paleontological, and terrestrial surface processes.

Workshop 13 (W13)

The Colors of Light: Using Spectrometers in High School and Middle School Science Classes

Barbara Stewart, François G. Amar, Robert Kirk, Mitchell R.M. Bruce
Department of Chemistry, The University of Maine

Location: 421 Aubert Hall

The InterChemNet project includes a system for integrating a UV-visible spectrometer with a laptop computer to allow students to collect their own spectral data and then to analyze it online. There is also a provision for quizzing students and leading them through the appropriate analysis. The system has been successfully adapted for high school use by Michele Benoit who will share her experience with the system and with curriculum development. Curriculum materials are available and include determining the amount of caffeine in soft drinks, looking at colors in Water-Based Inks, finding the FD&C Food Dyes in Gatorade, and analyzing various sunscreens. ***Activities will include:*** 1) Overview of how spectroscopy works; 2) Hands-on use of spectrometers; 3) Review of curriculum materials; 4) Discussion/input on future course offerings at UM; 5) Apply for loaner systems for classroom use. Visit the Website: www.interchemnet.com and click on *High School* in the top menu for more info.

Workshop 14 (W14)

A Model-Centered Approach to Earth Science Instruction

Suzi D. Shoemaker
Casa Verde High School, Casa Grande, AZ

Location: 201 Bryand Global Science Center

This workshop provides participants the opportunity to use some of the Earth Science curriculum materials that have been created following the Modeling Approach to instruction in the area of physical geology. Participants will use the materials as they are used in the classroom. One complete unit will be specifically covered, and remaining time will be used to go review the remaining units. These materials have been tried once in their current format, and feedback is requested from participants after they have had the opportunity to work with them first-hand. The materials are available to everyone, free of charge – I only ask that if you use them you give me feedback so that I can continue to refine and improve on what I have completed thus far.

Workshop 15 (W15)

Supporting Students in Creating Scientific Explanations

Joseph S. Krajcik
School of Education, University of Michigan, Ann Arbor, MI

Location: 102 Bennett Hall

The National Science Education Standards stress that students need to be able to develop explanations using evidence and think critically and logically to make the relationships between evidence and explanations. Although many science classrooms have students engage in hands-on activities where student experience phenomena, many classrooms fall short when it comes to having students think critically about data and construct scientific explanations that require students to interpret the results of experiments and apply them to scientific arguments and explanations. This workshop will provide science teachers with classrooms examples, supported by research, of how to support students to learn how to construct explanations. I will discuss a model of how to support students in creating scientific explanation. Teachers can careful scaffold students creating explanations by using a format of claim, evidence and reasoning. This model of scientific explanations supports students making connections between experiments and the science concepts they are investigating. Through the process students develop a deeper understanding of the science concepts as well as experience in creating scientific explanation. Participants will also examine how to develop rubrics to gain knowledge of how students are progressing as well as provide students with feedback.

Workshop 16 (W16)
Modeling Light

Gregg Swackhamer
Glenbrook North High School, Northbrook, IL

Location: 302 Bennett Hall

"Modeling" is a set of principles for designing and implementing instruction. Workshop participants will at first participate in the role of students by developing and then deploying models of light to account for shadows, pinhole projections, images, and the photoelectric effect as time permits. The real story, though, will be the models, not answers to typical problems. Salient features of the different models will become apparent as they are used to describe, explain, and predict the behavior of light successfully and unsuccessfully. Several student difficulties that have been pointed out by physics education research (PER) will be confronted. Finally we will discuss the instructional sequence to see how modeling and PER informed its design. Discourse will be encouraged and directions for further work in modeling will be identified. Participants who have laptop computers are encouraged to bring them.

Workshop 17 (W17)
Warming Up the Climate for Women in Science and Mathematics Classrooms and Communities

Sharon Barker
Director, Women's Resource Center
The University of Maine, Orono, ME
and
Virginia Nees-Hatlen
Director, Center for Teaching Excellence
The University of Maine, Orono, ME

Location: 219 Little Hall

Students are socialized to bring very different expectations, experiences, skills, and deficits with them into the classroom, into career choices, and into lifetime career development, depending on their gender. It is the role of science and mathematics educators to prepare female students to succeed in fields in which women have been traditionally underrepresented, and to prepare male students to succeed working in more diverse environments.

Our goal as educators should be to treat students fairly but not necessarily the same, and to ensure that all students have the opportunity to participate fully in our classrooms and in the larger scientific community.

This workshop will help you recognize ways in which science and mathematics classrooms are affected by gender dynamics, and to consider alternative ways to plan and structure content and activities in the classroom so that all students have equitable learning opportunities.

Poster Abstracts

Poster Session
Monday, June 21, 2004
3:45 PM – 5:15 PM
Wells Main Dining Room

P1 Curriculum Development based in Teachers' Scientific Research Experiences*

Jonathan Moyer, Robert Blaisdell and Jessica Odell
Master of Science in Teaching Program, The University of Maine, Orono, ME

Developing high school science curricula that are meaningful and engaging to students demands basing curricula on actual scientific research. To that end, three University of Maine Masters of Science in Teaching (MST) students participated in "Research-related Curriculum Development in Science and Mathematics" at The Jackson Laboratory. The MST students engaged in cutting-edge biological research and developed inquiry-based curricula on that research. The poster will detail the research-related curricula development of the MST students, including an overview of their curricula, the suggested audiences, the enduring concepts of their research, and information on the internship program itself.

*Work supported by the Howard Hughes Medical Institute and a gift from the Fleet National Bank, a Bank of America Company and Trustee of the Lloyd G. Balfour Foundation.

P2 Identification of conceptual deficiencies in introductory geology courses, based on assessments of prior knowledge and pre- and post-course assessments

Alan D. Wanamaker, Stephen A. Norton and Jeffrey C. Owen
Department of Geological Sciences, The University of Maine, Orono, ME

Prerequisite knowledge and pre- and post-instruction assessments were designed for three introductory geology courses at the University of Maine. The assessments were created with collaborative involvement of the course instructor and science educators to target essential knowledge, concepts and skills. The assessments provided baseline data on students' incoming background knowledge (general scientific concepts and skills), as well as students' gains in understanding on specific concepts and skills at the completion of instruction. Conceptual deficiencies of students in introductory geology courses were identified from these assessments. The conceptual deficiencies provided feedback on student learning and instructional effectiveness that will be utilized for the next iteration of instruction. This research was helpful in objectively evaluating lecture and laboratory content, and the attainment of the essential learning outcomes of the courses. The identification of conceptual deficiencies of students is useful, alerting instructors to concepts that are misunderstood or difficult to grasp, thus requiring special attention early in the course.

P3 Preparing Teachers to Teach Sound: Research and Curriculum Development

Katherine Menchen and John R. Thompson
Department of Physics and Astronomy, The University of Maine, Orono, ME

Our ongoing research involves exploring student understanding of sound and sound phenomena as part of the process of developing instructional materials to improve student learning, especially among pre-service teachers. Our current focus is on sound propagation. We have previously reported, based on responses to written questions, that the concepts of propagation and resonance are not functionally distinguished by many students. More recent student interview data confirm this earlier work. In addition, the interviews indicate student difficulties with certain properties of media or objects that are propagating sound. We have been using our research results to develop curriculum that addresses the difficulties described above. For example, establishing clear boundaries that distinguish between situations involving propagation and those involving resonance is an important step in resolving these issues. We will discuss our findings, as well as how they have shaped the curriculum.

P4 Measuring Student Understanding of Density, with Geological Applications

Emily L. Klingler, Stephen A. Norton and Jeffrey C. Owen, Department of Geological Sciences,
and John R. Thompson, Department of Physics and Astronomy, The University of Maine, Orono, ME

Density is a fundamental scientific concept central to the explanations of many observable phenomena. Education research on the teaching and learning of density has occurred in Physics, Chemistry, and Biochemistry and suggests that many students hold an incomplete understanding of density, even after considerable laboratory instruction. A preliminary investigation of students' understanding of density in introductory Earth Sciences courses suggests some similarities to the findings from these studies, including students' fragmentary understanding of the role density plays in various Earth Science processes.

The proposed study will involve roughly 240 students in Environmental Geology (ERS 102) at the University of Maine during the Fall 2004 and Spring 2005 semesters. Existing baseline data from pre-/post-course assessments in several Earth Science courses, including ERS 102, will provide a means for comparing the effectiveness of the course's traditional laboratory curriculum with a revised laboratory curriculum that includes a specially-designed, inquiry-based laboratory exercise on density at the beginning of the semester. Pre- and post-course assessments will determine students' gain in understanding of density and improvement in appropriate use of the concept in explanations of Earth Science phenomena.

P5 Identifying Student Concepts of 'Gravity'

Roger Feeley, John R. Thompson and Michael C. Wittmann
Department of Physics and Astronomy, The University of Maine, Orono, ME

We have investigated student concepts of "gravity" among non-science majors, pre-service K-12 teachers, and high school students. Both interview and survey questions were developed or modified from those in the literature. Students were questioned on their reasoning about the behavior of objects on the surface of a planetary body (e.g., the Earth or the moon) and the causes of this behavior. Results will be presented indicating that the survey successfully elicited student difficulties with various aspects of gravity, including the tendency to attribute gravity to the presence of an atmosphere, and to dissociate the concepts of gravity and weight.

P6 Using *CARLA* in College Anatomy & Physiology Coursework

Leonard Kass
Department of Biological Sciences, The University of Maine, Orono, ME

Effective teaching in large enrollment (over 200 students) courses in the biological sciences is both common at universities and challenging. One of the ways that students could be assisted in learning physiology is to be regularly provided with homework assignments. Along with weekly assignments is the need for them to self-assess the degree to which they have retained content information. Toward this end, I have recently implemented a web-based teaching tool that I have named CARLA (Computer Assisted Review and Learning Assessment) in Bio208 (Anatomy & Physiology) at the University of Maine in a semester that ended in May 2004. CARLAs current rendition utilizes "BlackBoard ® " and "CourseCompass ® "in allowing the students to take review and assessment exams in preparation for the actual class examinations. Analysis of its effectiveness toward accomplishing course objectives will be provided.

P7 Learning General Chemistry Concepts through Participation in Environmental Monitoring

Marek A. Sitarski
Department of Chemistry, Husson College, Bangor, ME
sitarskim@husson.edu

Project-based learning is perceived as an active and attractive approach for students and teachers. Elements of this mode of instruction can be extended even to the freshmen science courses where students are introduced to basic principles of the discipline. Introductory-level students may not be ready to undertake independent research, but they can participate in some aspects of their instructors' research. Environmental monitoring is an accessible source of activities, very well suited to teaching basic principles. I present one such activity, on probing coastal haze, which I developed for students of freshmen Chemistry at Husson College. Students are measuring total aerosol mass concentration, respirable aerosol concentration, temperature, barometric pressure, relative humidity, wind speed and direction, and visual range. Method of estimation of aerosol mass concentration in the coastal air, based on the atmospheric visibility and utilization of a linear regression equation, is the principal result of this activity. Results of the measurements from each field trip are added to the linear correlation plot of visibility vs. inverse aerosol concentration, making it more reliable. This on-going project teaches students the concepts of phase transitions, colligative properties, light extinction, Tyndall effect, coagulation of colloidal particles, and elements of atmospheric chemistry.

P8 PhysTEC: Physics Teacher Education Coalition

Paul Hickman
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PhysTEC aims to dramatically improve the science preparation and teaching skills of future elementary and secondary teachers. A self-sustaining Coalition will improve teacher preparation in a growing number of institutions resulting in a new generation of elementary and secondary teachers that will enable students to experience physics and physical science as an engaging and exciting activity. The American Physical Society (APS), in partnership with the American Association of Physics Teachers (AAPT) and the American Institute of Physics (AIP), initiated PhysTEC in response to national reports calling for the improvement of K-12 science teaching. Components of the program include: (1) establishing a long-term, active collaboration between physics education departments, and the local schools; (2) a teacher-in-residence (TIR) position allowing a master teacher to fully participate in course revisions and teaching; (3) the redesign of physics courses based on physics education research results; (4) the redesign of science methods courses to emphasize inquiry-based teaching and learning; (5) the establishment of a mentoring program to provide a valuable induction experience; and (6) the active participation of physics faculty to improve and expand the school experiences for their students.

P9 PAL K-12 Constructivist Curriculum Units: Ecology and Motion

Larry Latour and Steve Philbrick
Software Engineering Laboratory, Dept. of Computer Science, The University of Maine, Orono, ME

PAL is the Programming and Adaptive Learning project in the Computer Science Department's Software Engineering Lab. We have primarily been exploring the role of programming, in all of its guises and disguises, in constructive K-12 learning environments. These environments include, but are not limited to, traditional programming languages at all levels (from text based languages for high school students to iconic text free languages for the very young), languages embedded in traditional tools such as Powerpoint, Word, and Excel, modeling languages such as Stella, Starlogo, Stagecast Creator, hybrid languages such as Microworlds Logo, and Robotics languages such as those used for the Lego Rcx programmable brick.

We currently are involved in the development of curriculum toolkits using a variety of such programming environments. Two such units of interest to this conference are an ecology unit using Starlogo, and a motion unit using Lego robotics. The complete collection of resources under development is called our "PAL Closet", roughly equivalent to the closet of resources a good teacher has to draw from when developing curricula. This poster provides a summary of our work. These resources include traditional classroom curriculum units, teacher support materials, self-study materials, workshop plans, models, and additional tools and documentation support.

P10 Role of Diverse Representational Modes in the Learning of Physics*

David E. Meltzer
Iowa State University, Department of Physics and Astronomy, Ames, IA

I will report results of a variety of investigations aimed at exploring the role of diverse representational modes in the learning of physics. These include (1) student learning difficulties with standard representations such as graphical representations of vectors, (2) relationship between student problem-solving performance and the particular representational mode in which a problem is posed, and (3) evolution of student thinking regarding certain standard representations over the course of instruction.

*Supported in part by NSF REC #0206683

Continuing Education Unit (CEU) Information
Conference Services Division
The University of Maine

The Continuing Education Unit (CEU) has been designed as a uniform unit of measurement to facilitate the accumulation and exchange of standardized information about individual participation in non-academic credit continuing education programs. The CEU permits the individual to participate in many different kinds of programs while accumulating a uniform record available for future reference.

One Continuing Education Unit is defined as ten contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

Examples:
5 hour workshop would award 0.5 CEU
10 hour workshop would award 1.0 CEU
22 hour workshop would award 2.2 CEU
45 hour workshop would award 4.5 CEU

What Is An EDIS CEU?
The EDUCATION IN-SERVICE CONTINUING EDUCATION UNIT (EDIS CEU) has been approved by the State Department of Educational and Cultural Services (DECS) to be used toward teacher recertification. Programs conducted under the purview of Conferences Services Division, identified by an EDIS designator, have met the criteria established by the State Department of Educational and Cultural Services for determining approval of recertification programs. The majority of EDIS courses have been offered at the request of classroom teachers or their representatives.

HERE IS SOME IMPORTANT INFORMATION TO NOTE: Since Continuing Education Units are based on ten hours of participation for each unit and the DECS recertification credits are based on 15 hours of participation for each credit, the DECS will accept EDIS CEU on a 2/3 ration.

Examples:
1.5 CEU is equal to 1 recertification credit
3.0 CEU is equal to 2 recertification credit
4.5 CEU is equal to 3 recertification credit
9.0 CEU is equal to 6 recertification credit

How to Register for CEUs:
Conference Services provides a non-academic credit program completion form to participants desiring CEU records. Once you have completed a program that has received approval to grant CEUs, you can fill out a form to request a CEU transcript. The sponsor or chairperson of the program will have copies of that form available for participants when the program ends. To receive a transcript, the Conference Services office must receive a request form signed by you and the chairperson or sponsor along with payment of $5.00 for the transcript processing fee.

How are Continuing Education Units (CEUs) Recorded on Your Record?
When completing the program, a participant's record of completion is recorded on that person's non-academic transcript in the Conference Services office. At the same time, a notice of completion will be forwarded to the participant.

Can CEUs be Changed to Academic Credit?
CEU credits are not transferable to academic credit. Should you need additional information or further clarification, please contact University of Maine, Conference Services Division, Orono, ME 04469. Telephone: 207-581-4091 or Fax: 207-581-4097.