

Physics Education Research Conference 2001

Research at the Interface

Rochester, New York

July 25-26, 2001

Research at the Interface

There are several areas of interest that can be used to characterize the work of physics education researchers. These areas include conceptual learning/conceptual difficulties, problem solving skills, epistemological issues, individual and social issues (including teaming, learning styles, gender, race and ethnicity) and the role of context in learning. This conference will focus on research that explicitly crosses over the "boundaries" of two or more of these areas. An example is the role of conceptual understanding in successful quantitative problem solving. Another example is the importance of epistemological considerations in teaching for conceptual understanding.

Manuscript Submission and Review Process

If you intend to submit a manuscript for inclusion in the *first* PER conference proceedings, you should have already submitted four copies of the manuscript to Scott Franklin (Co-chair of PERC 2001). Manuscript requirements are posted on the conference webpage (<http://piggy.rit.edu/franklin/perc2001.html>). If you intend to submit a manuscript and have not yet done so, you should leave 4 copies of your manuscript for Karen Cummings care of (at) the Hyatt hotel reception desk. ***Manuscripts can not be accepted after Monday, July 23.***

If you submit a manuscript for inclusion in the conference proceedings, you are expected to help with the review of manuscripts if requested to do so. (Even if you don't submit a manuscript, we may ask you to help review. But under that condition, you would, of course, have much more right to refuse). ***All reviews are to be completed before the end of the conference on Thursday, July 26.*** (We know you reviewers can do it!!) Manuscripts and reviews will be mailed out to the authors for revision within a week. Revised manuscripts must be returned by September 1, 2001 if they are to be accepted for publication.

Purchase of Conference Proceedings

Orders can be placed for the conference proceedings during the PER poster session on the evening of Wednesday, July 25 (see attached schedule), during the morning break on July 26 or immediately following the closing session of the conference. Orders can also be placed following the conference by contacting Karen Cummings at karen@rpi.edu or 518-276-8077. **The cost will be \$25 payable as cash or check** (sorry no credit cards) payable at the time of order. Checks should be made out to "Physics Education Research Conference". We anticipate that the proceedings will be approximately 100 pages in length. The book is unlikely to have a hard cover but it will be professionally bound with the title printed on the cover and on the spine of the book.

Conference Schedule

Wednesday, July 25

3:00 pm-10:30 pm

3:00 p.m. - 5:00 p.m. *Main AAPT Meeting Invited PER Session to Kick Off the PERC
“Studying Student Learning Through Classroom Behaviors”*
Highland D, Rochester Riverside Convention Center

5:00 p.m.-7:00 p.m. *Gala Picnic Dinner-* George Eastman House
(AAPT main meeting event-ticket required)
Buses load from Main Street side of the convention center and will return to
convention center in time for poster session set-up.

7:00 p.m.-7:30 p.m. *Poster Session Set-up*
Grand Ballroom D on the second floor of the Hyatt

7:30 p.m. - 10:30 p.m. *Contributed Poster Session and Reception*
Grand Ballroom D on the second floor of the Hyatt

Thursday, July 26

8:00 am-3:00 pm

All events on 2nd floor of Hyatt-125 E Main St., Rochester, New York

8:00 am - 8:10 am *Welcome and overview* Grand Ballroom D

8:10 am -10:10 am *Opening Session- “Making Connections”* Grand Ballroom D

10:10 am-10:30 am *Morning break* Grand Ballroom F

10:30 am-12:00 pm *Breakout Session 1* (Three Parallel sessions)

Session 1A *“Connecting Concepts to Problem Solving-I”* Ballroom A

Session 1B *“Context, Gender and Beliefs”* Ballroom B

Session 1C *“Social Constructivism”* Ballroom C

12:00 pm –1:00 pm *Luncheon* Grand Ballroom E
Memorable entertainment graciously provided by Jose Mestre

1:00 am-2:30 pm *Breakout Session 2* (Three Parallel sessions)

Session 2A *“Connecting Concepts to Problem Solving-II “* Ballroom A

Session 2B *“Epistemological Considerations & Conceptual Development”* Ballroom B

Session 2C *“Problem Solving: Connecting Mathematics to Physics “* Ballroom C

2:30 pm-3:00 pm *Closing Remarks* Grand Ballroom D

Session Details

“Kick-off Session” - Main AAPT Meeting

3:00 - 5:00 p.m., Wednesday, July 25

Highland D, Rochester Riverside Convention Center

“Studying Student Learning Through Classroom Behaviors”

Explaining Trends in Observable Group Behaviors using Out of Class Interviews

Valerie K. Otero

School of Education

University of Colorado at Boulder

Classroom observation data, including field notes and videotapes, can be a valuable tool for studying student learning. However, it is often difficult to infer a student’s conceptual development from classroom observations alone. On the other hand, it is difficult to fully understand a student’s conceptual development based upon decontextualized situations such as out-of-class interviews. In order to get a more complete picture of what students have learned as well as how they have learned it, we must look at both the cognitive and social aspects of learning. Classroom observations can provide information such as students’ interactions with tools (such as laboratory apparatus and computer simulators) and students’ interactions with each other and with tools. Out-of-class interviews can provide information about what the student seems to understand about a particular concept. In this presentation, I will discuss methods for analyzing group scientific behavior including coding and representing the data. I will also discuss how a richer picture of learning can be established by a superposition of in-class and out-of-class data.

Questions First (Q1ST): The challenges, benefits, drawbacks, and results of asking students questions prior to formal instruction

William Leonard

Department of Physics and Scientific Reasoning Research Institute

University of Massachusetts

Amherst, MA

This spring we began a research study comparing the outcomes of two sections of calculus-based introductory college physics. Electronic homework and a classroom communication system (Classtalk) were used in both sections, but the styles in which they were used were different. In one section, lectures preceded asking questions using Classtalk, and homework was due after the material was covered in class. In the other section, homework was due before class, and Classtalk questions were used to stimulate discussions and motivate lectures. We will report on some initial findings from this study.

Student Behavior and Conceptual Learning in Introductory Physics Labs*

Ronald K. Thornton
Center for Science and Math Teaching
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Medford, MA 02155
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For many years we have observed students learning force and motion (mechanics) concepts in introductory physics labs that use guided discovery curricula (RealTime Physics) enabled by microcomputer based laboratory (MBL) tools. The students work in groups of three and the MBL software and hardware allow students to measure experimental results and display them in real time. Many previous studies using the FMCE show that most students (75 to 90%) learn force and motion concepts in these MBL laboratories. We have videotaped student groups over the entire semester. By carefully analyzing the behavior of these student trios, we have identified a characteristic set of behaviors for those who learned and those who did not. We are able to characterize student behavior as they progressively learn a concept. In addition, we observe the positive and negative effects that group dynamics can have on individual student conceptual learning. Videotaped examples will be shown and discussed.

*This work was partially funded by the National Science Foundation and the Fund for the Improvement of Postsecondary Education (FIPSE, US Department of Education).

Observing students' use of computer-based tools during collision experiments

Elizabeth A. George
Maan Jiang Broadstock
Wittenberg University;
Jesus Vazquez-Abad
Université de Montréal

We are investigating the contributions that microcomputer-based laboratories (MBL) and digital video-based laboratories (VBL) can make to undergraduate students' learning of momentum and energy conservation principles. As part of this research, we have observed and videotaped laboratory teams as they used MBL, VBL, and photogate tools in collision experiments. These data were collected during three semesters of an introductory physics course. The videotapes were analyzed qualitatively and quantitatively to provide information in two categories. The first category, students' use of the tools, includes practical aspects such as time spent on various tasks and how particular software features are used, as well as how students interact with the tools and use them to provide information and evidence in support of their conclusions. The second category, students' conceptual understanding, provides information about what students see in the data, how they explain their results, and difficulties they have with momentum and energy concepts. Supported in part by NSF grant #REC-9804922.

Session Details

PERC Opening Session

8:10-10:10 am, Thursday, July 26

Hyatt Grand Ballroom D

“Making Connections”

Jose Mestre is ‘Master of Ceremonies’.

Following Presentations by the invited speakers (see below), a 40 minute question/discussion session will ensue between the presenters and the audience. There will be a moderating panel chaired by Lillian McDermott.

Emphasizing Social Aspects of Learning to Foster Success of Students at Risk

Eugenia Etkina

Graduate School of Education

Rutgers University

etkina@rci.rutgers.edu

The Extended Physics program at Rutgers University provides a successful alternative to the traditional introductory courses for students at risk of failure. We discuss methods for addressing problems that students at-risk face in introductory physics with special emphasis on the social aspects of learning. We share our experience in creating an effective program within the structure of a research university.

Connecting Concepts to Problem Solving

Steve Kanim

New Mexico State University

Why do we assign textbook homework problems to students in the introductory course? Most instructors hope that these problems serve both to enhance conceptual understanding and to improve problem-solving skill. Many students, however, pay little attention to concepts when solving standard end-of-chapter problems. Is this because they do not understand the underlying concepts, or are there other issues? In some cases we have found that providing explicit connections between concepts and problems helps students to solve the problems in a more meaningful fashion. In other cases, our investigation into student difficulties with standard problems has revealed unanticipated conceptual difficulties. Examples will be given of student responses to conceptual questions and traditional problems in the context of electricity and magnetism.

The Importance of Epistemological Considerations in Fostering Conceptual Development

Andy Elby

University of Maryland, College Park
College Park, MD

In this talk, we give an overview of epistemology research, and we argue that researchers and curriculum developers can benefit from attending to epistemological considerations even if their primary concern is conceptual development.

First, we briefly review research into students' epistemologies and their views about the nature of knowledge and learning. In a nutshell, students in physics class exhibit epistemological stances that are difficult to change in a lasting way and that correlate with conceptual learning in many contexts. Some current research projects try to pinpoint the causal links underlying that correlation, by focusing on how students' epistemologies depend on context and affect their behavior. For instance, students who view physics knowledge primarily as disconnected formulas have no reason to try to link physics concepts to personal experiences or intuitions. By contrast, students inclined to seek coherence have reason to look for connections between different chapters or even different courses.

The second part of the talk is directed at teachers and researchers developing curricula focused primarily on conceptual (as opposed to epistemological) development. By attending to epistemology when analyzing how students interact with their materials and when updating those materials, curriculum developers can learn a great deal that is valuable to them in creating environments that foster concept learning. We base the argument on video clips of students working in small groups on a U.Md. physics tutorial. In certain moments, a student's difficulty learning the relevant concept stems not from misleading preconceptions, or from the inability to organize conceptual building blocks, or from poor reasoning skills; the difficulty stems from an unproductive epistemological stance, a stance the tutorial fails to nudge. This epistemological insight can help us make the revised tutorial a better environment for conceptual change. In short, even if we don't care about epistemological development as an end in itself, we can't escape epistemological considerations when attempting to foster conceptual development.

Pretending to Be Schoenfeld

Sanjoy Mahajan

Cambridge University

Alan H. Schoenfeld is Professor of Cognition and Development at U. Cal. Berkley. He got his Ph.D. from Stanford University in Mathematics and has written several seminal papers including: "Learning to Think Mathematically: Problem Solving, Metacognition, and Sense-Making in Mathematics", "Toward A Theory of Teaching-In-Context" and "Purposes and Methods of Research in Mathematics Education". (All of these are posted at his web page <http://www-gse.berkeley.edu/Faculty/aschoenfeld/>)

In April of 2001, Sanjoy Mahajan wrote the following e-mail to Karen Cummings:
Dear Karen,
Maybe you can get Alan Schoenfeld to come to the PERC if you write him and say: "In interests of building cooperation between the PER and Math education research communities, we impoverished PER people would like you to talk about conceptual understanding and problem solving. We unfortunately cannot afford travel expenses. In the probably unlikely event that you are able to speak anyway (Rochester July 25 or 26), we would be delighted. An alternative is that a PER person who knows and greatly respects your work would talk about it. I hope that you are well and not too busy. -Sanjoy

The end result of that e-mail is this presentation.

Session Details

Breakout 1A

10:30 am-12:00 pm, Thursday, July 26

Ballroom A

Connecting Concepts to Problem Solving-I

Invited Presenters:

Leith Allen (Ohio State University)

Steve Kanim: (New Mexico State University)

Connecting Concepts to Problem Solving

David E. Pritchard and Phillip Dukes (Mass. Inst. Of Tech.)

Inductive Support of Related Quantitative and Conceptual Problems

We have preliminary data on the extent to which answering conceptual questions on a topic helps with a subsequent quantitative problem on the same topic and vice versa. Our research was performed using CyberTutor, which administers free response questions with multiple layers of hints and subparts, and judges proficiency based on the number of hints and wrong answers submitted on the way to the solution. We divided a class of 100 students into two equally skilled groups and administered the conceptual problem and then the quantitative problem to one group, reversing the order of presentation to the other group. Alternatively we administered variants of a problem with the conceptual parts before vs after the quantitative part. Our preliminary data shows very little positive correlation in either direction. In contrast, we find strong inductive support of related problems that demand numerical responses vs analytical responses: the number of errors on the second problem can be reduced by up to 40% (four standard deviations).

Session Details

Breakout 1B

10:30 am-12:00 pm, Thursday, July 26

Ballroom B

Context, Gender and Beliefs

In this session we will examine the creation of educational environments which support student learning from a variety of perspectives: curricular shifts (infusing traditional courses with material traditionally reserved for advanced level classes), cultural / contextual mediation of student learning (how these environments critically shape student learning), and gender (the effects and role of gender in conceptual learning). Brief presentations will be given by each author. Significant time will be devoted to discussing relationships among these varying perspectives. The audience is encouraged (and expected) to bring relevant data / environmental descriptions to be discussed in the context of these perspectives.

Invited Presenters:

Lawrence Escalada (University of Northern Iowa)

Investigating the Impact of Implementing Visual Quantum Mechanics on Student Learning and Student/Instructor Beliefs

Aspects of the Visual Quantum Mechanics¹² (VQM) instructional materials have been adapted and implemented into a university physical science course for pre-service elementary education majors and various high school physics classrooms. The VQM materials utilize a learning cycle pedagogy involving interactive, simulation computer programs and inexpensive devices (e.g., light emitting diodes, lightsticks, glow-in-the-dark objects) to introduce basic quantum physics ideas within the context of fundamental physics concepts. A brief description of how the VQM materials and strategies were adapted and implemented will be provided. The results found on student conceptual learning and student/instructor attitudes and beliefs will also be discussed.

*Supported in part by NSF Grant #ESI-9730586 and a Iowa Space Grant Consortium Phase I - "Seed" Grant 1. Escalada, L. T., Rebello, N. S., & Zollman, D. A. (2001). *Solids & Light*. Manhattan, KS: Kansas State University. 2. Escalada, L. T., Rebello, N. S., & Zollman, D. A. (2001). *Luminescence: It's Cool Light!* Manhattan, KS: Kansas State University.

Laura McCullough (University of Wisconsin-Stout)

Does learning come in pink and blue? Gender and learning.

Noah Finkelstein (University of California San Diego)

Context in the Context of Physics and Learning

Noah Finkelstein will introduce the idea of re-focusing the lens of physics education research to explicitly include context (or what is sometimes called culture). In fact, this fits well with what the PER community has been doing implicitly for a long time. (A strong

case can be made for how all of the big reform projects can be viewed from a cultural / contextual vantage point.) What seems to be rather pressing is a discussion of what is meant by context. At the last AAPT meeting, the word "context" was used to refer to:

- various representational styles (graphical versus text)
- differing problem formation (e.g. Mestre's surface vs. deep structures)
- differing areas of physics content (energy in mechanics versus thermo)
- immediate activity / environment (students talking v. working on paper)
- broader activity (lab vs. lecture)
- course style (reform interactive class vs. traditional style)
- application (school based vs. real world / informal)

This interactive session will include a discussion of why and how it will be useful for the PER community to more seriously consider what we mean by "context".

Session Details

Breakout 1C

10:30 am-12:00 pm, Thursday, July 26

Ballroom C

Social Constructivism

Invited Presenters:

Euginia Etkina (Rutgers)

Non-Traditional Instruments which help to Develop and Assess Student Understanding Epistemologies and High Level Thinking Skills

Valerie Otero (University of Colorado)

Ron Thornton (Tufts University)

Lev Vygotsky (<http://www.ced.appstate.edu/vybio.html>) and Piaget

(<http://education.indiana.edu/~cep/courses/p540/vygosc.html>) both place significant emphasis on the social context of learning. Hence, they are associated with the term “Social Constructivism”. The three speakers in this session are grouped together because they too are doing research which acknowledges the importance and impact of social and cultural issues in student success (or lack their of) in interactive (constructivist) classrooms.

The presenters intended to engage the audience in a discuss of their work through presentation of video and other data.

Session Details

Breakout 2A

1:00 pm-2:30 pm, Thursday, July 26

Ballroom A

Connecting Concepts to Problem Solving-II

Invited Presenters:

Bill Gerace (U. Mass Amherst)

Karen Cummings (Rensselaer Poly. Inst.)

There have been several fledging experiments done that attempt to determine if there is a correlation between levels of conceptual understanding and the ability to solve related quantitative problems. We will begin this session with a presentation of several of the existing data sets (both our own and those of other researchers).

We will then present a cognitive frame work by which we can begin to think about the connections between conceptual understanding, qualitative problem solving and quantitative problem solving. Why are qualitative problems often more difficult for students to answer than quantitative problems are? Should we be asking our students to do more qualitative problem solving? If so, with what justification? What are the signatures of expertise in physics?

Through an interactive experience, we will examine the thought processes involved in development and solution of qualitative problems of varying degrees of complexity. In closing, we will engage in a group discussion about experimental choice and design for those interested in studying problem solving.

Session Details

Breakout 2B

1:00 pm-2:30 pm Thursday , July 26

Ballroom B

Epistemological Considerations and Conceptual Development

Invited Presenters:

Andy Elby (University of Maryland)

David May (Ohio State University)

Jeff Saul (University of Central Florida)

This interactive session addresses the connection between students' epistemological beliefs and their learning in introductory physics classes. Although evidence suggests that epistemological preconceptions may play as large a role as conceptual preconceptions do in student learning, most curricula do not address epistemological issues as deeply or systematically as they address common conceptual difficulties. Instead of the usual presentations, we plan to host a participatory data-analysis session. We will show epistemologically-rich raw data of three types: videotapes of students working on tutorials, transcripts from students getting interviewed about their physics experiences, and written "Weekly Reports" in which students reflect on their learning. In each case, participants will analyze what's going on epistemologically, with a focus on the interface between students' epistemological stances and their conceptual learning, and a related focus on the implications of these epistemological considerations for curriculum development. The precise format--for instance, how much time participants spend discussing data in small groups vs. one big group--will depend on the number (and personalities!) of people who show up.

Session Details

Breakout 2C

1:00 pm-2:30 pm, Thursday, July 26

Ballroom C

Problem Solving: Connecting Mathematics to Physics

Invited Presenters:

Kathy Andre Harper (Ohio State University)

Problem Solving in Physics: Some Mathematical Links

Tom Foster (Southern Illinois University Edwardsville)

Research on Problem Solving in Mathematics and Physics

Sanjoy Mahajan (Cambridge University)

Is there a connection between an over reliance on mathematical formalism and rote learning in physics?

Planned Menus (Subject to Change)

Costs included in the PER conference fee.

7:30 pm-10:30 pm July 25- Reception & Poster Display

Grand Ballroom D on the second floor of the Hyatt

(Menu for reception includes: steamship round of beef, penne pasta station with marinara & alfredo sauces, raw vegetables, cheese & crackers, roasted tomato bruschetta, California rolls, coffee, iced tea, and a cash bar.)

10:10 am-10:30 am July 26- Morning break Grand Ballroom F

“Java Break”, includes: cappuccino & espresso, assorted biscotti, butter cookies, chocolate dipped fruit & dried fruit, assorted soft drinks & mineral water

12:00 pm-1:00 pm July 26 Luncheon in Grand Ballroom E

“Genesse Buffet”, includes: mixed garden greens with assorted dressings, roasted potato salad, fruit salad, roasted sirloin with shiraz sauce, baked salmon with herbs & roasted tomato sauce, Chef's choice of potato, rice, or pasta, fresh vegetables, rolls, coffee & tea.

Questions/Problems Related to the PER Conference

Please contact Karen Cummings (Hyatt) or Scott Franklin (RIT-Physics) at <franklin@acd157a-055.rit.edu>