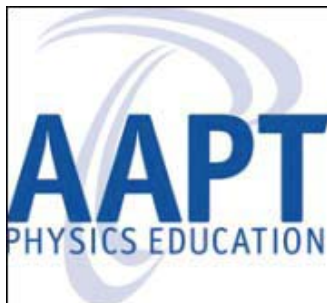


# Physics Education Research Conference 2011

*Frontiers in Assessment: Instrumentation, Goals & Practices*

August 3 – 4, 2011

Omaha, Nebraska



PERLOC





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## **Conference Overview**

### **Frontiers in Assessment: Instrumentation, Goals & Practices**

The theme of the 2011 PER conference will be Frontiers in Assessment: Instrumentation, Goals & Practices. We hope this theme will generate productive dialogues about issues of assessment and help our field grow by highlighting assessments that go beyond traditional approaches.

### **Motivation**

Assessments are fundamental to education. To borrow from Cole Porter: Teachers do it. Researchers do it. Even students in their seats do it. In physics education, researchers have used assessments to probe aspects relevant to learning such as student knowledge, reasoning processes, attitudes and beliefs, and abilities. Teachers use assessments to find out what their students know, engage students, help students learn, and to judge the effectiveness of their teaching. More broadly, people tacitly assess their own performance in a variety of tasks in their everyday lives, while explicit self-assessment, which is critical for learning, may be less common and a challenge to teach. Although everyone does it, not everyone does it in the same way nor for the same purposes.

In a sense, assessments are the instruments of physics education research. Our understanding of our research is only as good as our understanding of what instruments can (and cannot) tell us. New instruments allow for discovery of new phenomena and development of new knowledge. Discussion of assessment is important as our community broadens the scope of the phenomena we would like to examine, the measurements we would like to make, and therefore, the instruments we need. We believe it is timely to bring discussion of assessment issues into the foreground of the PER community.

In the broader field of educational assessment, there is a rich discussion about issues of validity and reliability of various assessment tools as well as alternative modes of assessment, such as formative assessment, student meta-cognitive reflections, portfolios, and performance assessment. Physics education researchers have begun to take up and examine these diverse assessment practices.

For every research study in our field, researchers need to think deeply about the assessments that are used, including their validity and reliability; methodology; alignment with learning, teaching, and research goals; overall purpose; implicit assumptions; and how our current assessment instruments are or are not meeting our objectives as teachers, researchers and learners.

**Organizing Committee:**

David Brookes (*Florida International University*), Brian Frank (*University of Maine*), Elizabeth Gire (*University of Memphis*), Matty Lau (*University of Pittsburgh*), & Noah Podolefsky (*University of Colorado*).

The Organizing Committee for the PERC 2010 Conference would like to express gratitude to the following individuals for their invaluable assistance:

Lyle Barbato, Cerena Cantrell, Noah Finkelstein, Tiffany Hayes, Bruce Mason, and Mel Sabella.

*The conference program and other information can be found on the web at:*

<http://www.compadre.org/per/conferences/2011/>

## Outline Schedule

### *Wednesday, August 3*

#### **3:00pm – 4:30pm: Bridging Session** (Harper Center- Hixson Lied Auditorium)

Assessment Lessons from K-12 Education Research: Knowledge Representation, Learning, and Motivation.

*Lorrie Shepard, University of Colorado at Boulder*

Complex Interactions between Formative Assessment, Technology, and Classroom Practices. *Edward Price, California State University San Marcos*

Discussion

#### **4:30pm – 5:00pm: Break** – Set up contributed posters. (Harper Center Ballroom A/B)

#### **5:00pm – 7:00pm: Banquet and Dinner Speaker** (Harper Center Ballroom C)

Standards-Based Grading with Voice: Listening for Students' Understanding. *Andy Rundquist, Hamline University*

#### **7:00pm - 10:00pm: Contributed Poster Session** (Harper Center Ballroom A/B)

### *Thursday, August 4*

#### **7:30am - 8:30am: Breakfast** (Harper Center Ballroom A/B)

*Continuing discussions around contributed posters*

#### **8:30am - 10:00am Morning Parallel Sessions**

#### **10:00am - 10:20am Coffee Break** (Harper Center Ballroom A/B)

**10:20am - 12:20pm Plenary Session** (Harper Center- Hixson Lied Auditorium)

Research and Development of Enhanced Assessment Tools for Chemistry Education. *Thomas A. Holme, Iowa State University*

Defining and Assessing Competence in Science: Lessons Learned the Hard Way. *James W. Pellegrino, University of Illinois at Chicago*

Student Engagement in Disciplinary Assessment  
*Co-presenter: Janet E. Coffey, University of Maryland*  
*Co-author: David Hammer*

**12:20pm - 1:50pm Lunch** (Harper Center Ballroom C)

**1:50pm - 3:20pm Afternoon Parallel Sessions**

## **Bridging Session**

**Wednesday, August 3 3:00pm – 4:30pm**

(Harper Center- Hixson Lied Auditorium)

*Presiding: Elizabeth Gire, University of Memphis*

**3:00pm – 3:30pm**

### **Assessment Lessons from K-12 Education Research: Knowledge Representation, Learning, and Motivation**

*Lorrie Shepard, University of Colorado at Boulder*

For 30 years, research on the effects of high-stakes testing in K-12 schools has documented the negative effects of teaching to the test. Most obvious is the reduction or elimination of time spent on science and social studies instruction, especially in high poverty schools. Less obvious is the harm to student learning in reading and mathematics when instruction is limited to repetitive drill on worksheets that closely resemble test formats. The lack of generalized, flexible understanding of underlying principles in K-12 tested subjects is similar to Mazur's experience with plug-and-chug versus conceptual test questions. The PER community is well aware of the importance of more complete representation of learning goals as a remedy to this problem. Equally important, however, are the assessment "processes," especially feedback and grading, that can either promote or deter students' engagement and willingness to take responsibility for their own learning. In this talk, I summarize learning and motivation research that has particular bearing on effective classroom assessment practices, in K-12 classrooms certainly, but even in university courses.

**3:30pm – 4:00pm**

### **Complex Interactions between Formative Assessment, Technology, and Classroom Practices**

*Edward Price, California State University San Marcos*

Interactive engagement (IE) methods provide instructors with evidence of student thinking that can guide instructional decisions across a range of timescales: facilitating an activity, determining the flow of activities, or modifying the curriculum. Thus, from the instructor's perspective, IE activities can function as formative assessments. As a practical matter, the ability to utilize this potential depends on how the activities are implemented. This talk will describe different tools for small group problem solving, including whiteboards, Tablet PCs, digital cameras, and photosharing websites. These tools provide the instructor with varying levels of access to student work during and after class, and therefore provide a range of support for formative assessment. Furthermore, they differ in physical size, ease of use, and the roles for students and instructor. These differences lead to complex, often surprising interactions with classroom practices.

**4:00pm – 4:30pm: Questions and Discussion**



## **Banquet**

**Wednesday, August 3 5:00pm – 7:00pm**

(Harper Center Ballroom C)

*Presiding:* Noah Podolefsky, University of Colorado

*Dinner Speaker:* Andy Rundquist, Hamline University

### **Standards-Based Grading with Voice: Listening for Students' Understanding**

Standards-based grading is gaining popularity at the high school level, including physics courses. The basic notion is to give your students a list of objectives upfront that they need to master. Students can reassess often and their final grade is determined solely by their last reassessment on each standard. It's the instructor's job to help students find ways of showing their mastery to you. I implemented this in a junior-level mechanics course where the small numbers allowed me to introduce a novel twist: all assessments had to include student's voice. This meant that students turned in pencasts, screencasts, and in-person assessments. Several days were also set aside for collaborative oral assessments, where students offered up honest advice and scores were mutually determined. In this talk, I'll share my experience trying out this pedagogical experiment and try to convey how it has improved my own understanding of my students' understanding.

## **Contributed Poster Session Wednesday, August 3 7:00pm – 10:00pm**

(Harper Center Ballroom A/B)

Contributed posters should be set up in (insert location) during the break between the bridging session and the banquet (4:30pm – 5:00pm). The poster session will begin immediately after dinner. The posters will be available during breakfast and throughout the day on Thursday. They must be removed by the end of the PERC on Thursday at 4:00pm. The list of contributed posters can be found on page 17 of this program. Authors of the odd numbered posters should stand by their posters from 7:00pm – 8:30pm. Authors of even numbered posters should be at their posters from 8:30pm – 10:00pm.

## Parallel Sessions

Thursday, August 4

Morning Parallel Sessions: 8:30am – 10:00am				
Title	Primary Organizer	Presenters	Type	Room
Formative and Summative Assessment in Upper-Level Physics	<i>Chandralekha Singh</i>	<i>Bradley S. Ambrose, Steven Pollock, Michael Loverude, Chandralekha Singh, Corinne Manogue</i>	Poster Gallery	3023A
Fostering Computational Thinking	<i>Marcos D Caballero</i>	<i>Michael F. Schatz, John B. Burk, Matthew A. Kohlmyer</i>	Poster Gallery	3028
Homework Systems for Learning	<i>Stacy Godshall</i>	<i>Scott Franklin, Yuhfen Lin, Raluca E. Teodorescu, Stacy Godshall</i>	Round Table	3027
Supporting Scientific Reasoning: From Teachers to Materials to Students	<i>Bruce R. Patton</i>	<i>Bruce R. Patton, Brian A. Pyper, Ruth Chabay</i>	Round Table	3029
The Group-Administered-Interactive-Questionnaire: A Cost-Effective Alternative to Individual Interviews	<i>Edit Yerushalmi</i>	<i>Charles Henderson, William Mamudi, Chandralekha Singh, Shih-Yin Lin</i>	Workshop	3023B

Afternoon Parallel Sessions: 1:50pm – 3:20pm				
Title	Primary Organizer	Presenters	Type	Room
Multiple Assessments of Multiple-Choice Assessments	<i>Chandralekha Singh</i>	<i>N. Sanjay Rebello, David E. Meltzer, Shih-Yin Lin, Vincent Coletta, Jing Li</i>	Poster Gallery	3027
Proximal Formative Assessment	<i>Rachel E. Scherr</i>	<i>Sarah B. McKagan, Rachel E. Scherr, Eleanor W. Close, Benedikt W. Harrer, Eleanor C. Sayre</i>	Poster Gallery	3029
Representation Issues: Using Mathematics in Upper-Division Physics	<i>Corinne A. Manogue</i>	<i>Edward Price, Michael C. Wittmann, John R. Thompson, Corinne Manogue</i>	Poster Gallery	3023
Moving Beyond Conceptual Inventories	<i>Beth Thacker</i>	<i>Beth Thacker, Patrick B. Kohl, Dedra Demaree, Eugenia Etkina, Mojgan Matloob Haghanikar</i>	Poster Gallery	3028
Redesigning Assessments to Motivate Students for Deeper Learning	<i>Yuhfen Lin</i>	<i>Yuhfen Lin, David T. Brookes</i>	Workshop	3023B

## **Parallel Session Abstracts**

### **Morning Parallel Sessions**

Poster Gallery: Formative and Summative Assessment in Upper-Level Physics

*Chandralekha Singh*

This poster gallery will explore formative and summative assessment issues in upper-level physics. The poster presenters will cover different areas of upper-level physics. The issues discussed will include whether assessments similar those used in introductory physics are suitable for upper-level courses and the types of assessment that are effective. A diverse set of formative and summative assessment tools will be discussed.

Poster Gallery: Fostering Computational Thinking

*Marcos D. Caballero*

Computation (the use of the computer to solve numerically, to simulate, or to visualize a physical problem) has revolutionized scientific research and engineering practice. However, computation is virtually ignored in most introductory college courses.

In this poster gallery, we present an overview of efforts to introduce computation undertaken in both high school and large enrollment university mechanics courses. Several key questions are highlighted for discussion. How can computation be introduced into courses that have a wide variety of student skill levels? How can students' abilities to use computer modeling be evaluated? What challenges do students face when developing a computer model? What is the role of epistemology for students who are learning this new tool?

Roundtable: Homework Systems for Learning

*Stacy Godshall*

Assessment of student work can be a vehicle for supporting student learning. In this roundtable, presenters will explore the issues and structures regarding how various kinds of assessments can support student learning and the research that has been done around this topic.

Roundtable: Supporting Scientific Reasoning: From Teachers to Materials to Students

*Bruce Patton*

Developing scientific reasoning is critical in Physics learning. In this roundtable, presenters and participants will explore the issues surrounding student development of scientific reasoning, how to best support it, and the research that has been done around this topic.

Workshop: The Group-Administered-Interactive-Questionnaire: A Cost-Effective Alternative to Individual Interviews

*Edit Yerushalmi*

Individual interviews are often considered to be the gold standard for researchers to understand how people think about a phenomenon. However, conducting and analyzing interviews is very time consuming. This workshop will present the group-administered-interactive-questionnaire as an alternative to individual interviews and engage researchers in discussions about the pros and cons of alternative data collection methods. We will discuss our experiences with both types of data collection tools in the context of understanding instructors' beliefs about problem solving. Both tools made use of an "artifact comparison" technique intended to mimic the instructional decision-making. The group-administered-interactive-questionnaire replaced the probing of a one-on-one interview with a group task preceded and followed by individual questionnaires. Workshop participants will compare these data collection tools to identify key design features. Collaborative analysis of data collected in both approaches will examine their validity and reliability in clarifying respondents' intentions.

### **Afternoon Sessions**

Poster Gallery: Multiple Assessments of Multiple-Choice Assessments  
*Chandralekha Singh, University of Pittsburgh*

Multiple-choice tests are used frequently in physics education as tools for assessing student learning. These assessments are often used to evaluate research-based curricula/pedagogies because they can be administered to a large student population, and are easy to grade, compare and analyze quantitatively. However, even with research-based multiple-choice tests, students' thought process is not revealed very well by the test answers alone. This session will showcase posters with examples of research highlighting advantages and limitations of multiple-choice assessments. These issues include correlation between students' performance on carefully designed multiple-choice tests and the same problems administered in a free-response format and graded on a rubric, gender effects, and other factors.

Poster Gallery: Proximal Formative Assessment  
*Rachel E. Scherr*

Classically, formative assessment has been considered in terms of changes made to lesson plans as a result of diagnostic testing. Proximal formative assessment is teachers' continual, responsive attention to learners' developing understanding as it is expressed verbally moment to moment: the process by which teachers carefully attend to specific aspects of individual learners' developing understanding, as instruction is taking place in real time (Erickson, 2007; Heritage, 2010). This is among the most subtle and challenging of formative assessment practices, yet is the one with perhaps the most potential impact on a teacher's ongoing activities in the classroom. This poster session will present research on proximal formative assessment being conducted for the Energy Project in the Department of Physics at Seattle Pacific University.

Poster Gallery: Representation Issues: Using Mathematics in Upper-Division Physics  
*Corinne A. Manogue*

Upper-division students must learn to apply sophisticated mathematics from algebra, limits, calculus, multi-variable and vector calculus, linear algebra, complex variables, and ordinary and partial differential equations. The presenters in this session will discuss how the representations that we choose may affect whether students are able to use this mathematics spontaneously and correctly, whether they can move smoothly between representations, and the extent to which their understanding of the mathematics enhances their understanding of the physics. The discussant will incorporate the perspective of research in undergraduate mathematics education as it applies to the representations that have been presented.

Poster Gallery: Moving Beyond Conceptual Inventories  
*Beth Thacker*

Many instructors across the country, particularly those teaching by non-traditional methods or interested in modifying their teaching techniques or curricula, find themselves in need of a more comprehensive assessment instrument. They would like to evaluate their instructional methods through a broader assessment of their students' skills, including laboratory, modeling (conceptual and mathematical), problem solving and critical thinking skills, assessed in the context of physics. They would like an instrument that can be used to compare their students' performance to that of other students nationwide.

In this targeted poster session, we will discuss the pros and cons of existing assessment instruments, which include assessments such as conceptual inventories and pre- and post-testing (mostly local), present work on assessments that go beyond conceptual inventories, and the need for broader, more comprehensive assessments, including examples of assessment instruments that might be useful to serve as a prototype.

Workshop: Redesigning Assessments to Motivate Students for Deeper Learning  
*Yuhfen Lin and David T. Brookes*

We all want the students to achieve higher level reasoning and learning. There are lots of reformed physics curricula that focus on teaching those higher level skills. However, most instructors struggle to come up with matching exam questions that will assess those higher level skills. In this workshop, we will examine the common assessments: homework and exams. We will discuss how to turn the regular end-of-chapter question into a question that requires students to apply higher level thinking and reasoning. We will also talk about some unusual places to look for possible homework and exam questions. Participants are strongly encouraged to bring a copy of their own final exam to the workshop for analysis and discussion.

## Plenary Session

Thursday, August 4, 10:20am – 12:20pm

(Harper Center- Hixson Lied Auditorium)

*Presiding: David Brookes, Florida International University*

**10:20am – 10:50am**

### **Research and Development of Enhanced Assessment Tools for Chemistry Education**

*Thomas A. Holme, Iowa State University*

The ACS Exams Institute has been producing norm-referenced exams in chemistry for over 75 years. Over the past decade, demands for assessment within chemistry education have increased, and the need has grown to consider additional ways to analyze data or develop assessment tools. This talk will note several examples of research and development related to chemistry exams and their use in classroom settings. Topics include, item-order effects, criterion referencing of exam items and differential item functioning.

**10:50am – 11:20am**

### **Defining and Assessing Competence in Science: Lessons Learned the Hard Way**

*James W. Pellegrino, University of Illinois at Chicago*

What do we want students to know and be able to do in disciplines such as Physics, Chemistry or Biology? How do we determine whether students are attaining our objectives? How can we use this information to improve student outcomes? Questions about defining and assessing competence are at the heart of the science education enterprise and they continue to challenge educators across K-16+. This presentation will provide concrete examples of how best to frame and address these issues using examples drawn from my work on the redesign of AP science courses and exams, my participation in developing the NRC Conceptual Framework for new Science Education Standards, and ongoing research on the validity and utility of instruments such as STEM concept inventories. A major point of the presentation is that principled assessment design should be an essential and driving part of the process of designing powerful and effective science learning environments.

**11:20am – 11:50am**

### **Student Engagement in Disciplinary Assessment**

*Janet E. Coffey, University of Maryland*

Co-author: *David Hammer*

Assessment in classrooms is often viewed as the responsibility of teachers. They typically serve as the ones judge the quality of work and advise students about necessary steps to make progress towards conceptual gains. By and large, then, assessment is something done by teachers to students. When students are involved in assessment, it is often as recipients and users of feedback from teachers. There's an analog to this in science. Assessment encompasses the process of peer review, when community members make judgments about the quality of work and provide feedback in reviews, and when funders decide whether to provide support to a research program. However, in

science, assessment also operates on a different level; assessment of ideas is intimately connected to doing science. In this talk, we examine the relationship between assessment and learning in science and in schools. We argue for engaging students in disciplinary assessment activities and for better coordinating the different purposes and roles for assessment.

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