NJAAPT

New Jersey
American Association
of Physics Teachers

SPRING 2007
SECTION
MEETING

March 16-17, 2007
Princeton University

Welcome to theNew Jersey AAPT Spring Section Meeting!

The focus of the 2007 section meeting is on Physics Education Research (PER) and how it impacts teaching and learning processes.

NJAAPT would like to give special thanks to Eugenia Etkina, Ed Groth, Toufic Hakim, Alan van Heuvelen, Paul LaMarche, Yee Ma, Yitzhak Sharon, and the Executive Board members for their efforts in helping to plan this section meeting.

And, of course, we especially thank our guest speakers, who have taken time out of their busy schedules to be here.

We hope that you will find the meeting informative and enjoyable, and we look forward to seeing you at future events.

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SCHEDULE of EVENTS

Friday March 16, 2007
Jadwin Hall

5:00 – 6:00 p.m.	Registration, Hors d'oeuvres
6:00 – 7:15 p.m.	Dinner – Joseph Henry Room
7:15 – 8:15 p.m.	Guest Speaker: **Alan van Heuvelen** "*Physics Education and the Needs of the Future Workplace*"
8:15 – 8:45 p.m.	Dessert and Visiting
8:45 – 9:30 p.m.	Tour of Princeton University Observatory (weather permitting)

SCHEDULE of EVENTS

Saturday March 17, 2007
McDonnell Hall

8:30 – 9:00 a.m.	Registration, Coffee
9:00 – 9:15 a.m.	Welcome: **Ray Polomski** President of NJAAPT
9:15 – 10:00 a.m.	**Edward F. (Joe) Redish** University Of Maryland *" New Directions in Physics Education Research"*
10:00 – 10:45 a.m.	**Eugenia Etkina** Rutgers University *" Investigative Science Learning Environment: Using the Processes of Science and Cognitive Strategies to Help Students Learn Physics"*
10:45 – 11:00 a.m.	Break

11:00 – 11:45 p.m.	**Rachel Scherr** University of Maryland *”Recognizing Valuable Student Thinking in Physics”*
11:45 – 12:15 p.m.	**Toufic Hakim** Executive Director of the AAPT
12:15 – 1:15 p.m.	Lunch
1:15 – 1:30 p.m.	Section Meeting
1:30 – 2:15 p.m.	**Bob Goodman** NJ Teacher of the Year 2005-06 Bergen County Technical HS ”*Teaching Physics First in High School*”
2:15 – 3:00 p.m.	**Michael Lawrence** West Orange High School ”*Physics Education Research: Theory into Practice*”

Alan van Heuvelen

Rutgers University

" Physics Education and the Needs of the Future Workplace "

Alan van Heuvelen received his B.S. in Physics from Rutgers University, and his Ph.D. from the University of Colorado. He is currently a professor of Physics at Rutgers University. Alan was awarded Fellow of the American Physical Society (1999) and the Millikan Award from AAPT (1999).

In the late 1980's, Alan developed a college version of a new physics learning system called Overview Case-Study (OCS) Physics. The instruction was originally supported by an *OCS Workbook* and by the *Active Learning Problem Sheets* (the *ALPS Kits*), with other materials developed later. The materials were based on the findings of physics education research and cognitive science and emphasized multiple representations of processes (paper-and-pencil and dynamical simulated processes), active student participation in their learning, the use of hierarchical methods to store and access knowledge, and contextually interesting, more complex problems. Over time Alan became aware of workplace studies, which indicated that traditional physics instruction was not going to meet the needs of the 21st century workplace. He has collaborated with Eugenia Etkina to build a new *Investigative Science Learning Environment* (*ISLE*) learning system based on her methods of scientific inquiry and on his own previous work in using cognitive strategies to enhance learning. During the past 14 years, he has led or co-led over 60 physics education workshops for physics professors and physics teachers on five continents and has given numerous talks concerning physics education.

The Workplace and Physics Education

The workplace moved from agriculture in the 1700s to manufacturing in the 1900s. Today, according to the NSF Shaping the Future 1996 review of education and to many other reports and studies, the 21st century "…national work force is changing dramatically…. the educational needs of the prospective work force are now vastly different." What are the educational needs in this new world? We look briefly at the evolution of that workplace and at the requests from a plethora of reports and studies concerning what is needed in our physics instruction. Do their requests match what we are doing? If not, how can we do better?

Edward F. (Joe) Redish

University Of Maryland

"New Directions in Physics Education Research"

E. F. (Joe) Redish is a Professor of Physics and an affiliate Professor of Curriculum & Instruction at the University of Maryland. For over twenty-five years he was an active researcher in theoretical nuclear physics. He always had a strong interest in teaching, and, upon discovering that a classroom was an even more complex strongly-interacting many-body system than a nucleus, switched his field of research to physics education. For more than a decade, Joe has been a leader in helping to establish a discipline-based education research community within physics. He has researched a variety of topics ranging from the implications of student expectations for their behavior in introductory physics to the difficulties advanced students have with quantum mechanics. His current interest is in building theoretical models for science education with ties to neuroscience, cognitive science, and the behavioral sciences. He is the winner of numerous awards for his education work including the Millikan Medal from the American Association of Physics Teachers, the Director's Distinguished Teaching Scholar award from the National Science Foundation, and a Distinguished Scholar-Teacher award at the University of Maryland.

Abstract

Over the past twenty-five years, research on introductory university physics classes has demonstrated that student learning is often significantly less than teachers hope and expect. Researchers all over the world have identified common and robust student conceptual difficulties in a wide variety of topics. Curriculum designers have built on this knowledge base to create improved learning environments. These research-based environments improve student conceptual learning significantly compared to traditional instruction. More recently, we have begun to go beyond a one-step view of misconceptions and conceptual learning. We are beginning to develop a more detailed model of how some of these student difficulties arise. Some are clearly not "brought in" by students, but are created "on the spot". I will introduce some theoretical elements gleaned from the neuro-, cognitive-, and behavioral sciences and show how they give insight into the "how" and "why" of student misconceptions and open up possibilities for the development of new and more effective pedagogical tools.

<u>Eugenia Etkina</u>

Rutgers University

" Investigative Science Learning Environment: Using the Processes of Science and Cognitive Strategies to Help Students Learn Physics"

Eugenia started teaching physics in 1982 in the former Soviet Union. At that time all Soviet students had to take 5 years of physics, having the same teacher for all 5 years. In teaching the same students for so long, the questions of goals become very important: what will these students take away from these 5 years? These thoughts led to the creation of a new physics curriculum, which her school allowed her to implement and which eventually became the topic of her Ph.D. dissertation. This curriculum made students active participants in the construction of physics concepts so their classroom life was somewhat similar to the practices of real physicists. It had a goal of engaging students in activities that simulated various processes though which practicing physicists acquire knowledge. It helped students develop scientific reasoning, and focused on evidence underlying new ideas. Students could take these abilities to their future lives and apply them every day. Additionally, she found that the program helped students to learn the concepts and laws of physics much better, and produced significantly more physics majors than other efforts.

Abstract

In this presentation I will describe how my own teaching experience, interactions with my former students, results of physics education research, cognitive research, and brain studies made me rethink and change what I do in a classroom as a teacher to help my students learn physics. I will describe the product of these changes - an interactive method of teaching, Investigative Science Learning Environment (*ISLE*), that helps students learn physics by engaging in processes that mirror the activities of physicists when they construct and apply knowledge. I will talk about three big projects carried out by members of the Rutgers Physics Education Research group which helped develop the learning system and study whether it helps students learn the content of physics, acquire abilities used by practicing scientists and most importantly, transfer these abilities while solving problems in content previously unfamiliar to the students. This curriculum can be used in high school physics, in college physics, and in the courses that prepare future physics teachers.

Rachel Scherr

University of Maryland

" Recognizing Valuable Student Thinking in Physics"

Rachel E. Scherr has been active in Physics Education Research for fifteen years. She did her graduate work at the University of Washington under Lillian C. McDermott and Stamatis Vokos. Her dissertation investigated student understanding of special and general relativity and developed collaborative active-learning materials that help students learn those topics effectively. Now a Research Assistant Professor with the Physics Education Group at the University of Maryland, her interests include conceptualizing "progress" in ways that go beyond right answers; helping physics graduate students become better tutorial TAs; and developing a set of open-source tutorials integrated with resources to help instructors adapt and implement them effectively in their local circumstances.

Abstract

How do we know "good scientific reasoning" when we see it? As experienced instructors, we know that evaluating right or wrong answers isn't enough; sometimes high-quality reasoning leads to non-standard solutions, and sometimes superficial rules generate numerically correct results. We sometimes have a feeling that a terrific student discussion is taking place without being able to put our finger on what's so terrific about it. Other times we have a sense that certain students don't know much physics, but "will do fine because they ask the right questions." What are "the right questions," and how do students come to ask them? What does "good scientific reasoning" look like, and on what basis do we make such judgments? At the University of Maryland, an ongoing project is developing measurement techniques for high-quality scientific reasoning. One such technique is a formal coding scheme for mechanistic reasoning, adapted from work done in the philosophy of science and applied to K-20 students. A second is a measure of "sensemaking" behavior based on demonstrations of intellectual independence, coherence, mechanistic reasoning, resourcefulness, and metacognition. A third line of investigation studies the role of student gestures in collaborative learning environments, in which the gestures not only tell what students are thinking but also seem to advance the students' thinking independently of their communicative purpose. The goal of this research is to develop well-defined measures that will help instructors to identify and cultivate valuable student thinking in the classroom.

Toufic Hakim

Executive Officer of AAPT

Dr. Toufic Hakim was selected to be the new Executive Officer of AAPT, starting in 2006. The AAPT is the nation's leading physics education organization with 10,000 members from over 30 countries. Its goal is to enhance the understanding and appreciation of physics through teaching. The AAPT supports the development of effective teaching resources and professional enhancement programs for physics teachers in universities, colleges, community colleges, and high schools.

Dr. Hakim holds B.S. and Ph.D. degrees in physics (B.S. Lebanese University, Ph.D. University of Delaware), as well as an M.S. degree in Electrical Engineering. He was professor of both physics and engineering at Jacksonville University, Florida. There he developed successful undergraduate research programs and an international studies department. Hakim served as the President of the Council on Undergraduate Research, as an American Council on Education Fellow, and as Assistant to the President at the College of New Jersey. Among his awards, he was the 1997 Florida Professor of the Year. At Kean University, Hakim provided leadership that energized the research environment and external funding activity resulting in a substantial increase in funding. He also participated in a national project to evaluate all undergraduate research projects funded by the National Science Foundation.

In his new position with AAPT, Hakim will channel his experiences in education, development and marketing to support the efforts of AAPT's members to improve the teaching of physics. He expressed his desire to "protect and build on the collegial environment of this wonderful organization".

"I am very enthusiastic about the opportunity to work with the large number of dedicated staff and volunteers who are passionate about, and committed to, physics teaching and learning," said Hakim. "I am honored to be chosen to serve AAPT, an organization whose mission I highly value and respect and whose impact cannot be understated. After all, advances in our national and global economy and enhancements in our quality of life depend in large measure on physics, the mother of modern science."

"Toward fulfilling my departmental or institutional mission, I look beyond the traditional, challenge the impossible, identify the reasonable. Once the target is set, I work hard to energize the team, plan ahead, and go full speed".

Robert Goodman

NJ Teacher of the Year, 2005-06

Bergen County Technical HS

"Teaching Physics First in High School"

Robert Goodman, the 2006 New Jersey Teacher of the Year, is the science chair and a teacher of physics and environmental science at the Bergen County Technical High School at Teterboro. He has been chosen to receive the 2007 *I CAN Learn – NEA Foundation Award for Teaching Excellence* and was a finalist for the *Horace Mann-NEA Foundation Award for Teaching Excellence*. He serves on the board of the recently formed Center for Teaching and Learning and is a member of the Education Advisory Committee for the Liberty Science Center.

Bob has worked as the Chief Executive Officer for a number of corporations including Harman Kardon, JBL

Consumer Products and Onkyo International Operations. He received his B.S. in physics from MIT, his M.A.T. in physics from SUNY Stony Brook and his Ed.D. in science education from Rutgers University. Kappa Delta Pi awarded him the 2006 Delta Xi Award for outstanding dissertation.

Mathematical Rigor + Physics First = Improved Science Achievement

There has been an ongoing debate, going back more than one hundred years, concerning the sequence in which high school science is taught. A central argument has been between advocates of "Physics First", which often supports a conceptual 9th grade physics course followed by chemistry and then biology, and those who prefer the traditional sequence of biology—chemistry—physics with a mathematically rigorous 11th grade physics course.

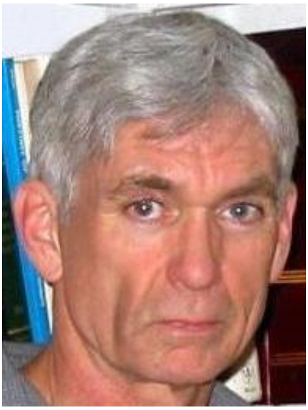
I will be discussing an approach that resolves that debate by incorporating the best aspects from the arguments of both sides. I will then report the results of a program, based on that new approach, which I have helped implement at the Bergen County Technical High School. That program has successfully raised the science and mathematics achievement of typical American students to levels that are at or above internationals standards. This has been accomplished by resolving two tensions that have persisted in science education:

- The need for a logical flow of science content from year to year versus the need for mathematical rigor in physics.
- The need to increase science literacy among all students versus the need to have a relatively small number of students reach the high levels necessary to go into medicine, science, mathematics, engineering, or technology.

Michael Lawrence

Physics Teacher
West Orange High School

"Physics Education Research: Theory into Practice"



Michael Lawrence has been teaching Honors and A.P. Physics at West Orange High School for the past 33 years. He became interested in Physics Education Research (PER) while pursuing his doctorate in Science Education at Rutgers University.

Dr. Lawrence has participated in science education research at Rutgers since 1990. His use of PER has led to his being a two-time state finalist for the Presidential Award for Excellence in Science and Mathematics Teaching, and co-author on research articles published in six different journals. Dr. Lawrence is currently a co-director of the Rutgers Astrophysics Institute (RAI).

Abstract

Physics Education Research (PER) is playing an increasingly prominent role in the delivery of physics instruction. The application of PER is in line with the New Jersey Core Curriculum Content Standards (NJCCCS) 5.1 and 5.7. In this presentation, Dr. Lawrence will use examples from his classroom to discuss how PER has influenced his teaching methodology. Areas of PER that will be emphasized in the presentation will include the use of expert problem solving, the Investigative Science Learning Environments (ISLE) method, multiple representations, anomalous data, and scientific misconceptions. Dr. Lawrence's presentation will conclude with a group discussion concerning where literature concerning PER can be found, how PER can be implemented into any physics curriculum, and resources that are available to facilitate the incorporation of PER into the curriculum.

NOTES

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