NJAAPT focuses on PER

The annual spring meeting of the New Jersey Section of the American Association of Physics Teachers (AAPT) focused this year on Physics Education Research (PER) and its impact on teaching and learning processes. Six speakers -- two from the University of Maryland, two from Rutgers University, and two from New Jersey public high schools -- addressed this at Princeton University on 16-17 March 2007.

Alan van Heuvelen of Rutgers began the meeting by asking whether our educational system is preparing students to take their place in a dramatically changing workplace in his Friday evening talk on "Physics Education and the Needs of the Future Workplace," and Bob Goodman of Bergen County Technical High School and Michael Lawrence of West Orange High School closed the meeting by speaking about special features of their classroom teaching which brought it abreast of the results of PER and the needs of today's students. Goodman focused on how he had been able to combine mathematical rigor with a physics course for ninth graders, followed by chemistry and biology courses in tenth and eleventh grades. Lawrence focused on his use of the Investigative Science Learning Environments (ISLE) method and other results of PER.

The status of PER and its applications were considered by the three Saturday morning speakers: E. F. "Joe" Redish of the University of Maryland, Eugenia Etkina of Rutgers University, and Rachel Scherr of the University of Maryland. Titling his talk "New Directions in Physics Education," Redish broke it down in to three questions:

What have we learned? Here Redish focused on what he called the "three big ideas" from PER: 1) constructivism - students' building new knowledge based on the knowledge they already have; 2) misconceptions - what students bring with them may not agree with what they are supposed to learn; sometimes this is "learned" and sometimes it is "created"; and 3) active learning -- active engagement is more effective than listening to a lecture in dispelling misconceptions and fostering accurate knowledge construction.

What have we done? Redish pointed out that misconception awareness has been documented in a wide variety of physics topics. about 20 concept inventories (with the Force Concept Inventory serving as the best-known prototype) have been developed, and many guided inquiry active learning environments have been developed.

What do we still need to do? Students need to know concepts, Redish agreed, but he added that they also need to know when and how to use them. They need the equivalent of a map to enable them to think about and understand their objective. Redish said this within the context of three aspects of brain behavior: association, binding, and selective attention. Our long-term memory stores huge amounts of information, Redish noted, but it is difficult to access. Chunking related information is important. What we want students to learn is patterns, not isolated pieces of information. Once elements of knowledge have been bound together, they are difficult to separate, Redish went on. We often try to teach our students the way we have bound information together in our brains, Redish observed, but we may forget how hard and long we worked for this to happen. If we kept this in mind, he said, we wouldn't get so easily frustrated when our students don't "get it" as soon as we hope they would. Under the heading of selective attention, Redish credited students with paying attention to what they think is relevant. But it may not be what we think is relevant, so we need to find ways to impart to them what is important for them to pay attention to.

Etkina, the developer of the ISLE system used by Lawrence, agreed with Redish that students learn best the things they are engaged with and began by asking, "What do we want our students to take away from our courses?" There are actually only a small number of structural elements of physics, she noted. What students need to learn is which of these elements is relevant to a given situation, and this requires organizing these structural elements in a useful way. Etkina depicted the brain's learning cycle as a continuous cycling of four steps: concrete experiences leading to reflective observations, followed by abstract hypotheses subjected to active testing, which leads to more concrete experiences, thus beginning the cycle all over again. Misconceptions are established by connections in the brain, Etkina added; they can be replaced only by productive ideas. And information can be transmitted from teacher to student only if the student understands the "code" for processing it.

All of what we know about learning should inform curriculum design, Etkina continued, noting that this is the basis for ISLE, in which students are asked to focus on how they know as well as what they know.

Scherr closed the Saturday morning presentations by considering "Recognizing Valuable Student Thinking in Physics." Good scientific reasoning doesn't always correspond to correct answers, Scherr emphasized. In fact, she noted, there are times that students get correct answers from using little or no reasoning at all.

What Scherr was interested in she called "sensemaking," as opposed to "answermaking." She discussed five indicators of "sensemaking": independence (coming up with an original idea), coherence (confronting a perceived contradiction), mechanistic reasoning (asking how things happen and wondering what would happen if . . . .), resourcefulness (invoking everyday experience), and metacognition (imagistic reasoning, by manipulating mental pictures)

The meeting was also addressed by AAPT Executive Officer Toufic Hakim, who brought greetings from the national office and