Classroom physicist

A new physics education research group has been formed, with David Meltzer taking a lead role.

David Meltzer isn't just content to develop new instructional methods for large-enrollment classes in the Department of Physics and Astronomy.

No, Meltzer and other members of a new physics research group are looking to go beyond the development of active-learning curricular materials.

"We are carrying out an integrated program to develop improved curricula to support the new instructional methods as well as carrying out basic research in the teaching and learning of physics," said the assistant professor of physics.

Meltzer, who was the Center for Teaching Excellence's Teaching Scholar for 2002-03, says that his research project is going along two parallel tracks.

The first looks at fundamental basic research - what concepts and ideas are difficult for students to learn, and what specific difficulties the students encounter.

"We try to develop curriculum materials to address those problems. Hopefully we'll learn how to help the students out," he said.

The second prong of his research focuses on developing and testing the instructional materials, and finding out whether students really understand the material that is given to them during instruction.

The research has been funded by four separate National Science Foundation (NSF) grants, totaling $414,000. Two of the grants are in conjunction with the Department of Chemistry and Tom Greenbowe, professor of chemistry, who directs a similar education research group in that department.

Meltzer says that such a program is needed in physics and astronomy classes as well. Students from the College of Engineering (approximately 1200 per semester) are required to take calculus-based general physics courses.

Additional non-physics majors take similar algebra-based courses including majors from microbiology, genetics and pre-medical and pre-veterinary students.

The NSF grants have helped Meltzer develop active-learning curricular materials for some of these courses, including a CD-ROM.

"Broadly speaking, active learning gets students more engaged with the materials in the classroom," Meltzer said. "Our materials pose lots of questions with the expectation that the students will have to answer those questions."

In his classes, Meltzer uses a "flash card" response system to obtain instantaneous feedback on multiple-choice questions from all students simultaneously. In addition, students spend a large fraction of class time working in collaborative groups on carefully structured work sheets.

"In my general physics classes, I try to keep lecturing to a minimum," Meltzer said. "I tell the students that I expect them to have looked through the material beforehand, so we essentially just review the information with a relatively short 'mini-lecture.' Then I give them a series of related questions that they answer with the flash cards."

Meltzer usually starts out each class period with the easier questions. As it gets deeper into the period, the questions become harder.

"As we move toward those questions, there is usually a lot of uncertainty," he said. "I then ask the students to work in small groups to talk about the questions together before 'voting' again on the answer. By working with each other, they develop an understanding of the material and often figure out the problems on their own.

"For introductory students, this is an effective method of studying the material," Meltzer continued. "I believe it's much more effective than just taking notes."

Meltzer's other NSF grant projects have investigated the relationship between the form of representation of physics concepts and the relative efficiency of student learning, and have also supported the development of active-learning curricular materials in thermodynamics.

"This type of active learning can be effective in virtually any size class in physics and astronomy," Meltzer said. "The main idea is to get the students involved.

"This is such a big project. We have just scratched the surface. There is so much still to look into," Meltzer said.