TESSI Research Project Supports New Teaching Model For Sciences

. . . Director Finds That A New Teaching Method Using Interactive Physics Software Proves to be Effective

Janice Woodrow, a physics education professor at the University of British Columbia, first saw Interactive Physics software being demonstrated at an American Association of Physics Teachers Conference. Interactive Physics is software that allows teachers to demonstrate both textbook and laboratory physics concepts to students at the high school and university levels. Woodrow immediately recognized the potential of Interactive Physics to support Outcomes-based Learning, which is the basis of her Technology Enhanced Instruction (TEI) teaching model. Technology Enhanced Instruction is instruction in which computers, multimedia technology, and related resources are used to aid student learning and access to information.

"The way physics is traditionally taught is highly mathematical," said Woodrow. "If you ask average high school students what physics is, most of them don't know. Students get into the physics classroom and see a bunch of squiggles on the board. To many of them, physics just doesn't have any meaning or connection to real-world phenomena."

The University of British Columbia and the Langley School District near Vancouver accepted a proposal from Woodrow to test the TEI model with quantitative results. Thus, the Technology Enhanced Secondary Science Instruction (TESSI) program was established in January 1993. TESSI was initially established in classrooms in two separate schools. Woodrow then selected two teachers, Aubry Franholtz and Gordon Spann, to work collaboratively with her on the project.

An early obstacle that needed to be overcome was technology jitters. The new interactive tools needed to be accepted as friendly and useful to the learning process, not as tutorial based instruction that might replace the human interface. This acceptance was achieved quickly by the intuitiveness and flexibility of Interactive Physics combined with interactive testing to access student learning interactively and provide results and analysis immediately. With custom tests taking as little as five minutes to prepare, the instructor can quickly identify problem areas with students, provide corrective activities using Interactive Physics, and have the students retest on the same concept to ensure the concept has been grasped. With this fully-integrated set-up, Farenholtz and Spann are able to present lessons in a seamless manner, switching between problems as they appeared in the textbook and as they were simulated in Interactive Physics.

Interactive Physics is the backbone of the TESSI program. Interactive Physics appears on a computer screen as a virtual drawing board, with an easy-to-use, intuitive interface. Students or teachers use the mouse to select drawing tools and constraints from icon palettes to draw objects. Physical properties such as mass, gravitational pull and velocity are assigned by typing in the amounts in user-selectable pop-up windows. Physical constraints such as pin joints and pulleys can be added, and then the "run" button is selected. Interactive Physics automatically animates the drawing in a simulation that represents exactly what would happen in the real world.

Interactive Physics displays values of selected physical variables simultaneously with the action of the simulation. This data can be seen as graphs plotted as the objects move, or as numerical output. In addition, data is stored in a tabular format that students can refer back to later or include in reports.

Interactive Physics is ideal for demonstrating many basic physics concepts including kinematics and dynamics in one dimension, mechanical and heat energy, vector kinematics and dynamics including relative motion, equilibrium, circular motion and gravitation, electrostatics and electromagnetism.

It's ideal for simulating concepts that are difficult to visualize, like relative motion, where you have two motions to take into account such as a boat crossing a river with a current; or a problem that involves studying the orbit of an electron in a magnetic field; or finding the velocity that a satellite must achieve in order to attain a stable orbit," said Woodrow.

In addition, changing a variable in an equation is as simple as a mouse click, allowing for many "what if" scenarios to be performed. In this manner, students grow to understand the nature of the problem itself, rather than focusing on finding a numerical answer that may not have much meaning.

With eight computers in the TESSI classrooms, students may choose to work alone or in groups. They are given the course material in the form of study guides. These guides include physics problems and supporting computer simulations. Students work through this material at independent rates, sometimes coming in after school and during lunch hours to extend their use of classroom resources. "Students like working on the computers because they are learning skills above and beyond physics," said Woodrow. "Students perceive that computer skills, in general, are very valuable. We also find that students are using the technology to complete assignments for other classes, such as chemistry, math or biology."

"It's a major change in the way students learn," said Woodrow. "We have found that students are very receptive in taking responsibility for their own learning and have become more self-motivated."

In the TESSI project, students may choose to perform labs with Interactive Physics, or in the regular laboratory. "As students get more experienced, they choose to look at the Interactive Physics simulations less and less. They eventually make the transition and visualize the concept and problem themselves, rather than having to turn to the computer. Finally, they can solve the problems on their own which is ultimately our goal. Once they're over that initial hurdle of not understanding what physics is all about, physics becomes easy for them," said Woodrow.

Janice Woodrow believes that one of the greatest achievements to evolve out of the new teaching model is that students finally make the connection between reality and the mathematical and symbolic "squiggles."

Results

Woodrow cites that in British Columbia, the average high school enrollment for Grade 12 physics is approximately 12% of the Grade 12 student population. The course is available as an option for those students who have completed Grade 11 physics. Those students who take Grade 12 physics are generally those who plan to pursue engineering, science or pre-med in college, and take it as a requirement for entry into those programs. Since the implementation of Interactive Physics and TESSI, enrollment in the two high schools' Grade 12 physics has increased to 28%.

"These high enrollment figures were not typical of the two schools before the implementation of the TESSI project," states Woodrow. Woodrow attributes the increase in enrollment to word of mouth and to the students in the junior grades who see the computers in the classrooms, play with them in their spare time, and then take the class because they are comfortable with the technology.

Word of mouth about the success of the TESSI project has also increased. The two teachers, Aubry Franholtz and Gordon Spann, were flown to Ottawa, Canada to receive the Prime Minister's Award for Teaching Excellence in Science, Technology and Mathematics, a national honor that the Canadian federal government bestows upon a select group of teachers. The TESSI project continues to grow. Recently, Woodrow added six more physics teachers to try the TESSI teaching strategies. She is also piloting materials for a distance education project to involve three physics students working from isolated school districts.

TESSI will continue for at least three more years and expand into chemistry, biology and general science, Woodrow feels confident that TESSI will continue to produce definitive results.

Early studies indicate that using technology and new teaching methodologies increases student retention, provides a deeper learning, gives students skills backed with an understanding, produces higher scientific literacy, increases communications and promotes group problem-solving.

Interactive Physics software continues to be the major software used in the TESSI project. The easy-to-use, intuitive program provides the most comprehensive, flexible solution for students to overcome the initial hurdle of conceptualizing physics problems in an environment that allows them to have fun and learn simultaneously.