

Cause Effect

A Physics Department, Redefined

Seattle Pacific University shows how a small liberal arts college can have a big impact on expanding physics teaching and improving student achievement.

By *Stamatis Vokos*

Founded in 1891 by the Free Methodist Church of North America, Seattle Pacific University (SPU) is a Christian institution of the liberal arts, sciences, and professional studies, offering 53 bachelor's, 11 master's, and three doctoral degree programs. Total student enrollment, as of autumn 2006, was 3,830 (2,979 undergraduates).

In 2002 the physics department had three tenure-track faculty; today it has seven. We attribute this remarkable growth to four factors: a department-wide focus on student assessment; collaboration with other academic departments and educational institutions, most notably the education department and local school districts; substantial administrative support within a culture that celebrates the scholarship of teaching and learning; as well as a strategic pursuit of external funding.

Student Assessment and Learning Gains. In 2003, the physics department embarked on the project called "Adaptation and Implementation of Research-Based Curricula in Introductory Physics Courses at Seattle Pacific University," which is funded under the National Science Foundation's Course, Curriculum, and Laboratory Improvement program (CCLI). Calculus-based and algebra-based course sequences were drastically altered through the adaptation and utilization of active learning physics curricula such as tutorials in Introductory Physics, Activity-Based Physics tutorials, and RealTime Physics. Students' conceptual understanding skyrocketed. On several nationally available concept inventories, learning gains doubled. On the Force Concepts Inventory, for instance, one measure of learning gains (g-value) increased from around 30% to about 60%.

The most important outcome of the NSF-CCLI project, however, is the SPU Learning Assistant (LA) program currently led by assistant professor of physics Lane Seeley. The LA program utilizes well-trained undergraduate

students as tutors in the teaching of introductory physics courses. This year, the department offered a specially designed course that allows the LAs to concentrate on more general issues of teaching and learning. The development of this course benefited greatly from the input of colleagues in physics and education from the University of Colorado, Boulder, and the University of Arkansas.

The LA program extends beyond physics majors and minors to encompass talented undergraduates from other sciences and engineering programs. In this way, it also serves as a natural recruiting setting for future science teachers.

Increasingly confident about its emerging ability to navigate the shoals of curricular reform, the department has piloted research-based laboratory materials for the introductory course being developed by Michael Loverude (California State University-Fullerton), Luanna Ortiz (Arizona State University), and Stephen Kanim (New Mexico State University).

Collaboration Across and Beyond SPU. There are many forces that influence the professional trajectory of a pre-college teacher. At both the pre-service and in-service levels, the dominant ones are the School of Education, the College of Arts and Sciences, and the school district. According to the national norm, these three institutions play integral roles but with little coordination. In contrast, the SPU approach is one in which all three institutional players have an ongoing collaboration.

The collaborative model being developed at SPU is based on the recognition that blending expertise in tackling teacher preparation issues is crucial. Furthermore, this collaboration includes and impacts the entire physics department faculty, students, and the curriculum.

The Resident Master Teacher (RMT) in the physics department is the nexus of the partnership among

education, physics, and local school districts, and plays an indispensable role in all aspects of the department's teacher preparation program.

The RMT at SPU is Lezlie Salvatore DeWater, a veteran teacher, science specialist, and professional development provider for Seattle Public Schools. Lezlie DeWater and Eleanor Close, assistant professor of Physics and Science Education, co-teach SPU's special content and science methods courses for prospective teachers. Pre-service teachers, therefore, get immersed in the inextricable blending of subject matter and pedagogical content knowledge. In addition, the RMT teaches a special course on the nature of science for non-science majors.

Long-term, authentic collaboration with school districts is an essential part of the department's effort. Science coordinators from several school districts and educational service districts consider the department an invaluable partner for numerous local, state, and national initiatives. The department, on the other hand, benefits tremendously from keeping a hand in the realities and mandates of the pre-college classroom to finding "laboratories" for the delivery of research-based professional development.

Administration Support Is Key. Strong support of departmental initiatives by all levels of the university administration has been crucial. The president, provost, deans of the College of Arts and Sciences and the School of Education, and the associate dean of Teacher Education understand the issues and work closely with physics department chair John Lindberg as well as the entire physics faculty to find ways to institutionalize gains and develop new programs.

One substantive example of this institutional support is the fact that the deans decided to move the science education tenure-track faculty position (vacated because of retirement) out of the School of Education and into the physics department. Another example is the funding provided by the university for a postdoctoral associate, who will be immersed in all aspects of the department's program so as to eventually have a positive impact on Christian higher education in physics and teacher preparation.

Sources of External Funding. Seattle Pacific University, with extensive support from the SPU Science Initiative, NSF, the Boeing Co., Lilly Endowment, and the PhysTEC joint project of the American Physical Society, American Association of Physics Teachers, and American Institute of Physics, has embarked on a long-term course to prepare and support teachers of science in ways that are guided by education research.

NSF has funded several departmental projects in the last three years. In addition to the CCLI project, the department has received a major grant to support the

project "Improving the Effectiveness of Teacher Diagnostic Skills and Tools."

In partnership with Jim Minstrell and Pam Kraus of FACET Innovations, and the public schools in three of the largest cities in Washington, the project is developing Web-based formative assessments to help teachers in grades five through 10 map out their students' modes of reasoning in foundational areas of physical science.

Most recently, the department (in collaboration with other sciences, mathematics, and education programs) received a Noyce Scholarship grant to attract prospective teachers. Finally, the department leveraged consistent support from Boeing to meet the stringent conditions required for funding to become the latest PhysTEC Primary Program Institution.

Not Only for a Chosen Few. Improving student understanding in the gateway courses, combined with targeted student recruitment, has increased interest in SPU's physics degree program. SPU now graduates five to eight physics majors each year—twice as many as a few years ago. Moreover, the number of female students who choose physics as a major or minor has increased significantly.

Guided by a common theological commitment that all students can and deserve to succeed in physics, and armed with the tools of physics education research, SPU faculty members have focused their attention on other aspects of the curriculum. The department is experimenting with research-based materials in modern physics, quantum mechanics, and classical mechanics, as well as courses for non-science majors. Δ

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Editor's Note

Seattle Pacific University recently became a member of the Physics Teacher Education Coalition (PhysTEC). Funded by the National Science Foundation, PhysTEC is led by the American Physical Society, the American Association of Physics Teachers, and the American Institute of Physics. Its goal is to improve the science preparation of future K-12 teachers by bringing together faculty from physics and education to work on ideas and curricular reform that emphasize interactive engagement and student-centered approaches to learning science.