Workshop Confronts the Health of Physics Education

On June 10, 2012, APS and AAPT held a two-day workshop at the American Center for Physics to tackle the issue of building physics programs with sustainable, healthy physics enrollments. Recruiting more physics majors creates the potential for more physics teachers. Representatives from fifty-five institutions, including twenty minority-serving institutions, attended the sold-out workshop on Building a Thriving Undergraduate Physics Program, which was sponsored by PhysTEC, APS, AAPT, and the National Science Foundation. The workshop followed the biennial Physics Department Chairs Conference.

“We were very impressed by the participation rate and the high level of interest we had in the workshop,” said Peter Muhoro, APS Bridge Program Manager and lead conference organizer. The workshop’s structure was based on SPIN-UP workshops, and added a new thread on teacher preparation.

Keynote speaker S. James Gates, a professor of physics at the University of Maryland and a member of the President’s Council of Advisors On Science and Technology, led off the conference with a presentation on the Engage to Excel Report: Producing One Million Additional College Graduates with Degrees in STEM. Physics Nobel Prize Winner Carl Wieman gave a “big picture” plenary talk on the national perspective on education research applied to improving physics learning.

Key parts of the workshop were four planning sessions in which small teams of institutions met with consultants who offered their expertise and advice as institutions developed action plans to strengthen their own physics programs.

Naresh Sen of the University of Toledo cited these small group breakout sessions as the best part of the workshop.

“Progressively focusing on what to do to implement changes in our department—this is something concrete we can take home with us,” he said.

Past and present PhysTEC site leaders had a strong presence at the workshop, presenting a series of inspiring case studies illustrating how physics departments were able to turn their programs into thriving ones. Gubi Sudhakaran described how the physics department at University of Wisconsin–La Crosse was on the brink of extinction until sweeping curricular reforms, aggressive recruitment, new academic programs, and flexible advising, among other efforts, turned it into a nationally recognized program.

Seven New Funded Sites Join PhysTEC

The PhysTEC project strives to improve and promote the education of future physics teachers. The project does this in part by selecting colleges and universities to develop their physics teacher preparation programs into national models with substantial project support. PhysTEC-supported sites have collectively more than doubled the number of physics teachers they graduate.

Bob Hilborn, Associate Executive Officer of AAPT, notes that the joint APS/AAPT project has already made significant progress towards increasing the number of physics majors interested in high school teaching. “This year’s solicitation for PhysTEC funding resulted in a set of strong proposals from a broad spectrum of colleges and universities,” he added.

The new features that this year’s funded sites bring to the PhysTEC program were emphasized by Theodore Hodgapp, APS Director of Education and Diversity. “Several sites intend to focus on the synergy between in-service and pre-service efforts, an interaction that PhysTEC is eager to develop,” he says.

PhysTEC students at the University of Alabama-Tuscaloosa will gain early teaching experiences through the school’s partnership with Alabama Science in Motion (ASIM), a statewide program that provides high-tech laboratory equipment and experiences to poorly supplied science classrooms, as well as professional development for secondary science teachers.

The University of Missouri-Columbia proposes a host of efforts to establish a professional community of physics teachers that engages future teachers on campus and new teachers in nearby schools. Projects include a living-learning community for freshman students and mentoring from exemplary high school teachers.

“A number of this year’s universities are adding to already robust undergraduate physics programs,” said Monica Plisch, APS Associate Director of Teacher Education. Fewer than half of the 27,000 physics depart-

programs produce fewer than two graduates per year, typically not enough to sustain specialized staff or courses in physics teaching. Moreover, the total number of graduates estimated at 260 per year is tiny compared to the 3000 teachers each year who find themselves at the front of a physics classroom for the first time.

In spite of the overall grim picture, T-TEP identified a handful of exemplary programs that produce relatively large numbers of physics teachers (up to the number of physics teachers per year, typically not enough to sustain specialized staff or courses in physics teaching. Moreover, the total number of graduates estimated at 260 per year is tiny compared to the 3000 teachers each year who find themselves at the front of a physics classroom for the first time.

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As her strokes became sloppy, her swim coach yelled, “Elbows up! Elbows up!” With a semester of high school physics under her belt, she was immediately struck by the realization: “Of course! That would reduce my arm’s moment of inertia.” Robinson knew that she had been hooked.

After graduating from Virginia Tech with a bachelor’s degree in physics and a master’s in education, Robinson went on to teach at Wakefield High School in Arlington, VA for several years. She currently works as a Teacher-in-Residence (TIR) at her alma mater, where her main focus is “recruiting the next generations of fantastic high school physics teachers.”

The TIR role applied classroom wisdom to the recruiting, training, and support of teachers of physics, and is an integral component of the university’s PhysTEC project, which began funding in the fall of 2011. To this end, Robinson has been working with colleagues at Virginia Tech to create a physics Learning Assistant program, bring more active-engagement strategies to introductory courses, and train future physics teachers.

Robinson said her first year as a TIR has been an incredible experience. “Not only have I been able to take advantage of having unrestricted access to liquid nitrogen, I’ve had the wonderful opportunity to work with dedicated educators who strive for excellence in physics teaching,” she said. Robinson said both the faculty at Virginia Tech and the national PhysTEC team have been highly supportive of her efforts. “I feel incredibly fortunate to have one of the most rewarding jobs in the world,” Robinson said. “Any success I’ve had comes from the fact that I’ve been lucky enough to spend time doing what I love.”

Task Force continued from cover

12 per year). These programs were also distinguished by exemplary practices, including active recruiting, early teaching experiences in physics, specialized courses on physics teaching and learning, mentoring by expert physics teachers, individualized advising by knowledgeable faculty, a rich intellectual community for graduates, and close collaboration between physics departments and schools of education.

To address multiple issues with a coordinated and effective national strategy, T-TEP recommends establishing regional centers in physics education. A regional center would serve the need for new teachers in its greater geographical area while also providing support to in-service teachers and contributing to state and national education policy. Regional centers would pool expertise in physics education, create vibrant communities of practice, and be a home for scholarly work. Moreover, regional centers could take multiple forms, based at one institution or a collaboration among multiple neighboring institutions.

Presented by APS, AAPT and AIP, T-TEP was funded through the PhysTEC project, which is supported by the National Science Foundation and the APS Campaign for the 21st Century. More information is available at www.phyteconference.org/taskforce.
Matt Johnson is gearing up for his second year as a high school physics teacher at Gahr High School in Cerritos, California, where he says he hopes to make his students love the subject enough to consider a major in physics. “I say I had the kind of job my young self would have called a dream job,” he said of his career before becoming a teacher.

Johnson enthusiastically made the career change to teaching high school physics after spending some years working in research. He earned a B.S. in Astrophysics and a minor in Cognitive Science from UCLA, followed by an M.S. in Computer Science with a concentration in Computational Neuroscience from University California, San Diego. “I have always known that if I had the opportunity to share my passion with young people then those that get taught in physics. It’s the root of all science, it’s a way to make math real, and it’s a lot of fun,” he said.

Johnson went on to get a single subject teaching credential in Physics from California State University, Long Beach, a PhysTEC site since fall 2011. Johnson says the PhysTEC program immediately plugged him into a physics teaching community and gave him the opportunity to experience truly great physics pedagogy. “Because of the PhysTEC program I essentially got to supplement my Science Methods course with PhysTEC Methods class, and that gave me a stronger handle on what it would be like to teach physics than perhaps all of my other classroom combined,” he said.

Johnson completed his credential last year while working as an intern at Gahr High School teaching College Preparatory and AP Physics. He’s not afraid to admit that his first year of teaching was extremely difficult. “I’ve worked some demanding jobs in my career, and last year was as rough as any of them,” he said. Challenges included constantly having to improvise and scrap lesson plans because they just weren’t realistic as first-time teachers.

Despite the challenges, Johnson says his experience teaching has been immensely rewarding. “My first year made me more confident than ever that I made the right choice switching careers,” Johnson said. He was able to develop connections and mentoring relationships with his students during his first year, something that he thought would take longer to cultivate. Johnson said it was particularly gratifying when students who had always shown a tendency to slack off turned out to excel in his classes. When graduation rolled around, Johnson received solemn tears, shakes and effusive hugs. “In short, I’ve been more confident than ever that I made the right choice switching careers,” Johnson said. He was able to develop connections and mentoring relationships with his students that lasted well into the summer. He is now an instrument maker at the University of California, Irvine. “I can have more fun than he was. “I thought I’d have the same kind of fun if I taught the right subject in high school,” Johnson said, and the subject could only be physics. “Physics was my first love, and I couldn’t imagine a career that didn’t involve sharing my enthusiasm with young people.”

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Measuring Success: Physics Teacher Growth at PhysTEC Sites

Through the PhysTEC project has a broad mission to improve and promote the education of future physics teachers encompassing a number of far-reaching goals, there is one clear measure of the project’s success—the number of new graduates highly qualified to teach physics. Among the most recent cohort of five supported sites to have completed their funding period, all but one institution show growth in the number of such graduates. Looking at the bachelor’s level, where PhysTEC activities, including recruiting, have the greatest influence, the total number of graduates increased from five in the first three years of funding to 18 in the following three years, a more than three-fold increase.

The University of Minnesota nearly doubled its number of graduates over a three-year period, while Florida International University and the University of North Carolina at Chapel Hill graduated their first physics teachers in recent years. The drop in teachers graduating from Cornell reflects a set of circumstances largely outside the control of the project, including budget cuts that eliminated the education department and uncertainty about the future of the certification program.

Another indicator of success is the number of future physics teachers in the pipeline at current PhysTEC sites. A PhysTEC future teacher is defined as a student at a PhysTEC institution who has committed to completing a program of physics teacher education. Among the four institutions that began funding in 2010, we can look at the rise in future teachers as a positive sign that these sites will realize success in graduating more physics teachers in the coming years. All four sites show increases in the number of future physics teachers at the undergraduate level. Supported sites employ a variety of recruiting strategies to attract more undergraduates as future teachers. Efforts may include implementing a Learning Assistant program, hiring a high school teacher as Teacher-in-Residence to excite students about teaching, offering scholarships for the physics teacher education program, and producing marketing materials to increase awareness of the PhysTEC program.

PhysTEC and the Next Generation Science Standards

The Next Generation Science Standards (NGSS) will replace the National Science Education Standards, which were originally published in 1995. Changes in technology, science education, and science content over the past 15 years should be reflected in the final NGSS document. 26 states have committed to give serious consideration to adopting the NGSS when published, and these new standards promise to transform K-12 physical science education.

The NGSS are built upon the foundation of the Framework document published in 2011. Helen Quinn, past president of APS and chair of the PhysTEC Advisory Board, chaired the committee that produced the Framework document. Central to the structure of the Framework is the weaving together of scientific practices, crosscutting concepts, and core ideas.

The Framework argues that scientific practices (analyzing and interpreting data) should not be separated from scientific ideas, whether they are core ideas specific to a discipline (matter and interactions), or crosscutting concepts in multiple scientific specialties (systems, for example). The NGSS will embody the Framework in grade-by-grade descriptions of what students should know and be able to do. Based on the feedback provided by physics teachers and PER experts, work remains to be done on the NGSS to realize the full vision of the Framework.

There are significant implications for teacher preparation in the sciences if the NGSS are adopted nationally. Elementary and middle school teachers will need to prepare students in all the major science disciplines, including physics. High school teachers will depend on the success of teachers in early grades if they are to help all students meet these standards before graduation. The preparation of future elementary and middle school teachers will depend on the success of teachers in early grades if they are to be well prepared for high school science. Teachers at all levels will need to evaluate students’ ability to analyze data and create arguments based on evidence, two areas not always emphasized in licensure programs.

APS and AAPT provided feedback on the initial draft in the spring of 2012. Individuals are encouraged to review and comment on the second draft of the NGSS when it becomes available, anticipated in late 2012. Also, look for discussion of the impact of the NGSS on science teacher preparation at the 2013 PhysTEC Conference.

About PhysTEC

The PhysTEC project funds selected universities (Supported Sites) to develop physics teacher preparation programs into national models. The project began in 2001 with an initial cohort of six sites. Eleven years later, the project has grown significantly and now has a total of 29 Supported Sites. These supported sites have collectively more than doubled the number of graduates highly qualified to teach physics.

The project aims to improve and promote the education of future physics teachers through a variety of additional activities. These include a coalition of more than 280 Member Institutions, conferences and workshops, an email discussion list, publications and presentations, and multiple special initiatives.

PhysTEC Membership

This map represents the 263 PhysTEC Member Institutions nationwide, including 29 Supported Sites and 27 Affiliate Members, representing over 30% of all physics departments that grant a bachelor’s degree (as of press time). To become a PhysTEC Member Institution, visit www.ptec.org/join.

*Read more details about the project mission and goals at phystec.org/about.