

New PhysTEC Sites

By Ted Hodapp

In 2007, PhysTEC began funding Cornell University, Florida International University, the University of Minnesota, and the University of North Carolina at Chapel Hill to develop their physics teacher preparation programs into national models. Each of these institutions now employs a Teacher-in-Residence to coordinate project activities and build bridges between physics departments, education schools, and local school districts; also each is developing a Learning Assistant program to offer prospective teachers low-pressure early teaching experiences. In addition, these universities are all able to take advantage of local strengths and resources to adapt their projects to local needs. These four join eight existing sites that continue to improve their physics teacher education programs.

Increasing under-represented students' access to excellent physics education is a long-term and vitally important goal of the PhysTEC project. **Florida International University (FIU)** in Miami, Florida educates more Hispanic students than any other institution in the country, and that diversity is reflected among FIU's physics majors. Site leader Laird Kramer has built a thriving learning community within the department, and is now seeking to expand these efforts to include educating teachers. Florida International is poised to provide the lion's share of highly qualified physics teachers to the southern tip of Florida, and especially to Miami-Dade County, one of the largest school districts in the country. Aspiring physics teachers face a heavy



Florida International University site leader Laird Kramer and physics students study the results of a computer-assisted momentum experiment. Photo by Ted Hodapp.

courseload that often makes it impossible to complete their undergraduate degrees and get certified to teach in four—or even five—years. The physics department and education school at the **University of North Carolina at Chapel Hill (UNC)** are attacking this issue head-on with their recently developed UNC-BEST (Bache-

lor's Education in Science and Teaching) major track. By reducing the number of credits needed for graduation, these departments hope to make graduation in four years with licensure to teach physics a more attainable goal.

Recruiting bright undergraduates to physics, and then to teaching, is

fundamental to building the country's physics teacher corps. **Cornell University** site leader Rob Thorne and Teacher-in-Residence Marty Alderman are collaborating with students at Cornell's Johnson Graduate School of Management to develop a webpage with recruitment resources to share with institutions around the country and beyond. Alderman has also used old-fashioned one-on-one conversation to attract record numbers of physics majors to School of Education recruiting sessions for future teachers.

Project leaders at the **University of Minnesota** are driving forces behind a number of unique outreach programs, including a physics road show called the Physics Force and a program for minority students and their parents called PACES (Parents and Children Experiencing Science). Site leader Cindy Cattell and Teacher-in-Residence Nancy Bresnahan are using these programs to promote teaching physics as a rewarding career, both to University of Minnesota undergraduates and to middle and high school students. With one of the largest undergraduate student bodies in the U.S., Minnesota has tremendous potential to recruit and prepare significant numbers of teachers.

Each of the newly funded sites struggles to embrace teacher education as a significant mission of a physics department in a research institution, but project leaders at each site are developing creative solutions to meet these challenges and to improve the visibility of physics departments' efforts to recruit and educate teachers.

2008 Conference: "Master Teachers: Change Agents for Teacher Preparation"

By Gabriel Popkin

The 2008 Conference on the Preparation of Physics and Physical Science Teachers was held in Austin, Texas on February 29th and March 1st. For the second straight year, the conference attracted a capacity crowd of around 120 physics and education faculty, administrators, K-12 teachers, and students, who soaked up two packed days of 90-minute workshops given by national experts on master teachers, assessment and evaluation, curriculum and teaching methods, and institutional partnerships.

Among the best-attended sessions were Ed Prather's workshop on interactive pedagogy, "Are you really teaching if no one is learning?" and Bob Beichner's workshop on his "Student Centered Activities for Large Enrollment Undergraduate Program (SCALE-UP)." Also very popular was a full-day workshop at the University of Texas at Austin on UTeach, one of the best-known and most successful math and science teacher preparation programs, which is now being replicated at twelve universities around the country through grants

"There were no 'knowers,' only learners."

—Valerie Otero, University of Colorado Education Professor

from the National Math and Science Initiative (NMSI).

Along with the workshops and plenary sessions, the conference provided an opportunity for members of the physics education community to connect with colleagues in other disciplines and with university administrators. Representatives from NASULGC (the National Association of State Universities and Land-Grant Colleges) the American Chemical Society, and Math for America led workshops and organized planning sessions for future multi-disciplinary initiatives in science and math teacher education.

Attendees provided overwhelmingly positive feedback on the program, and many told us that the Conference's compact size and intense focus created a particularly rich environment for teaching,



Helen Quinn (Stanford Linear Accelerator Center, APS Past President), Stamatis Vokos (Seattle Pacific University), and Valerie Otero (University of Colorado at Boulder) have an animated discussion between conference sessions. Photo by Ted Hodapp.

learning, and networking. Valerie Otero, a University of Colorado Education Professor, remarked on the collegial atmosphere—"there were no 'knowers,' only learners. The problem of preparing qualified physics teachers is so hard that everyone is looking for someone who knows the answer."

To build on the conference's success, project leadership plans to continue seeking out ways to engage physics departments and institutions in teacher education.

The 2009 PTEC Conference, with the theme "Institutional Change," will take place in Pittsburgh on March 13th and 14th, preceding the APS March Meeting. Project leader Ted Hodapp says, "At a time when policy makers are requiring more students to take physics in our nation's already understaffed classrooms, it is critical that we turn the excitement and momentum from the PTEC Conference into action, and results."

PTEC Member Profiles

By Monica Plisch

The Physics Teacher Education Coalition (PTEC) is a diverse network of institutions—now over 100 in number—committed to improving the education of future physics and physical science teachers. PTEC promotes effective practices in teacher education through conferences, workshops, publications, and electronic forums. Below are profiles of three member institutions that are highly engaged in teacher preparation.

Brigham Young University–Idaho

BYU–Idaho graduates three to five physics teachers a year, all of whom spend at least one semester in Brian Pyper's physics education research group. Pyper explains that BYU–Idaho's PTEC membership helps his future teachers "take their profession seriously, have confidence that the educational preparation they're getting is worthwhile and valuable, and that when they leave here, there's a larger community of professionals paying attention to student learning and in place to help them develop professionally." Speaking proudly of his students, Pyper says, "They are really sharp. If they stay in teaching they will be really excellent teachers."

Rutgers University–New Brunswick

Rutgers University is home to a highly regarded physical science teacher preparation program that graduates six to eight teachers a year with a master's



Allison Shaffer, Michelle Klingler, and London Jenks (from left) of BYU–Idaho's Research in Science Education (RISE) group examine research data. Photo by Brian Pyper.

degree and teaching certification. Director Eugenia Etkina says that her program goes against two common ideas in teacher education—one, that "knowing the subject matter is enough to teach it," and two, that "you can learn how to engage students by being told how to do it."

Etkina says that PTEC membership has benefitted her program by helping her spread the word about the importance of

pedagogical content knowledge—in other words, content-specific teaching methods—to more people than just the students in her own program. In addition, she points out that "just as teachers are isolated, those who prepare teachers are also isolated," and PTEC provides a community that reduces this isolation. Etkina is a member of the PTEC steering committee and the newly formed Task Force on the Professional Preparation of Teachers of Physics, and she

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—Eugenia Etkina, Rutgers University Education Professor

notes that such appointments help raise the profile of her professional activities in the eyes of university administrators.

Lone Star College–North Harris

Lone Star College–North Harris is a two-year college in North Houston, and represents PTEC's efforts to reach a broader and more diverse population of future teachers. Physics department chair April Moore says, "My colleagues and I wanted an inquiry-based program to meet the physics requirements of future elementary teachers on our campus. Had I not attended a PTEC conference, I would not have been introduced to PET." PET stands for Physics and Everyday Thinking, a research-based curriculum that engages students in activities to learn about fundamental ideas of physics and the nature of science. "This alternative to traditional lecture and lab instruction has been appreciated by those students who feared taking a physics class and who feel they learn best by doing something," says Moore.

To become a member of PTEC, a physics department must endorse the joint statement of AIP member societies on teacher education, submit a brief application, and have the support of the chair. For a list of PTEC members and information on how to join, please visit www.ptec.org.

Learning Assistant Workshop

By Gabriel Popkin

"The Learning Assistant experience helps students realize that teaching is a real intellectual challenge, and for many of them, this is exactly what they're looking for."

—Valerie Otero, University of Colorado Education Professor

If you go to an introductory physics recitation section at the University of Colorado at Boulder, you won't see an instructor at the blackboard. But you will find undergraduates—who were at the top of their classes in previous semesters—sitting at tables with groups of students and guiding them as they develop their understanding of physical concepts. These Learning Assistants help their peers master the fundamentals of physics, and often discover a passion for teaching in the process.

Now four years old, the Colorado Learning Assistant program is starting to attract attention from science faculty around the country who want to recruit strong students into teaching careers. To capitalize on this momentum, the project recently coordinated and sponsored a two-day workshop that brought 22 faculty members from a diverse group of 14 colleges and universities to Boulder to learn how to replicate Colorado's successes on their own campuses.

The workshop, which was led by a team of Colorado science and education professors, caught the Learning Assistants in action both in the recitation sessions described above, and in a science pedagogy course that all Learning Assistants take. This course provides the crucial opportunity for program leaders to impress upon the young teachers the importance, and difficulty, of truly engaging their students'

minds. As Valerie Otero, the science education professor who co-teaches the class, put it, "the Learning Assistant experience helps students realize that teaching is a real intellectual challenge, and for many of them, this is exactly what they're looking for." To demonstrate this, she had workshop participants and Learning Assistants work together to figure out how to guide hypothetical non-science majors from a naïve conceptual model of a phenomenon—in this case magnetization—toward a more sophisticated model.

Ted Hodapp, Director of Education and Diversity at the American Physical Society, explained the program's appeal: "Learning Assistant programs are a kind of surprise attack for students who haven't previously thought of themselves as potential teachers. By giving students a low-stress, low-commitment early teaching experience, physics departments can get them excited about teaching and recruit them into teacher education programs." Indeed, nine Learning Assistants were enrolled in physics and astrophysics teacher certification programs at Boulder in 2005–2006, as compared to one student in 2004–2005 (who was not a Learning Assistant). Nine may still not sound like much, but consider that only five students in the entire state of Colorado were enrolled in physics teacher certification programs in 2004–2005. If this model spreads to enough of the 767 undergraduate physics programs in the country,



Colorado education professor Valerie Otero works with two Learning Assistants on an experiment during the PTEC Learning Assistant Workshop. Photo by Ted Hodapp.

it could provide a significant number of the highly qualified physics teachers our nation's schools need. The program can also provide a major benefit to departments—Colorado faculty have shown that assessment scores have improved both among students in courses that use Learning Assistants as well as for the Learning Assistants themselves.

By the end of the workshop, most participants had generated plans for developing elements of a Learning Assistant program on their own campuses. The project supports these incipient efforts by tapping leaders around the country to create online resources and organize workshops and

panel discussions at conferences. Faculty from two other PhysTEC sites—Seattle Pacific University and the University of Arkansas—have developed their own Learning Assistant programs that reflect the unique styles of the lead faculty, and the particular needs of their departments. In addition, all four of PhysTEC's most recently funded sites are creating programs to recruit Learning Assistants from among their undergraduate ranks. These schools are among the growing number of institutions that are using Learning Assistant programs to give their undergraduates an early taste of teaching.

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—Ted Hodapp, Director of Education and Diversity, American Physical Society

Perspectives on Teaching:

Interviews conducted by Gabriel Popkin

Two recent PhysTEC graduates share their thoughts on teaching.

Aaron Debbink, Ball State University,
Class of 2006

Q: Where are you teaching, what subjects, and what grade levels?

A: This is my first year teaching at Pendleton Heights High School in Pendleton, Indiana. I am teaching AP physics, introductory physics, and integrated chemistry and physics (ICP). My students range from sophomores to seniors.

Q: What classes have you most enjoyed teaching, and why?

A: I have most enjoyed teaching the junior/senior level introductory physics and the senior level AP physics classes. I love watching students use their knowledge of physics and math to solve some unique real-world problems. These classes are usually at a level where I can give them a practical lab-based problem where they must use what they have learned to make an accurate prediction and then physically test their solution. There seems to be an unconscious disconnect in students' minds about what they learn in class and its applicability in the real world, and you can see this in their surprise when their solution actually works.

Q: What is your greatest challenge as a teacher?

A: My greatest challenge as a beginning teacher is not being consumed by my job. I've found that teaching is a profession that can consume as much time as I am willing to give. There are always ways to improve, lessons to tweak, lab and demonstration equipment to build, and many other things that will keep me busy for years to come. For as consuming as it can be some times, the variety and opportunity for creativity and improvement is one thing I love about the profession of teaching. It is never the same job from day to day, and it's only as boring as you make it.

Charlie Rea, University of Arkansas,
Class of 2006

Q: Now that you are a teacher, what do you like most about teaching? What are your greatest challenges? What have you learned about teaching since entering the classroom?

A: I like the feeling that my job has meaning and importance. No matter what career path a person chooses, a teacher is involved in helping people reach their goals.

The greatest challenge as a teacher at

"I like the feeling that my job has meaning and importance. No matter what career path a person chooses, a teacher is involved in helping people reach their goals."

—Charlie Rea, physical science teacher, Ramsey Junior High School, Fort Smith, Arkansas



Physics teacher and Ball State University graduate Aaron Debbink and a student study computer-generated data from a physics lab on kinetic energy. Photo by Aaron Debbink.

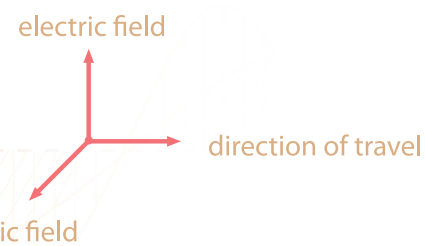
this level is that not all students show up ready or willing to learn. Education is far enough down in the hierarchy of human needs that in order to teach, we first must see to more fundamental needs.

Since entering the classroom, I have learned that teaching is less about what you know, and more about how much you care.

Q: What aspects of your education in the Arkansas PhysTEC program have you found most useful in the classroom?

A: First, I learned the importance of collaborating with one's colleagues. No teacher should ever need to feel alone in their goals or that they must do it all by themselves. Second, I learned a lot about the importance of meaningful, valid assessment of students as well as teachers.

Q: Do you have any stories of exciting



teaching moments, such as a student suddenly understanding a concept after much struggling?

A: My favorite moments as a teacher are when I finally understand how to connect the content with the students' interests. The moment when a student who has been zoned out perhaps for years in science class perks up when the content is related to skating, racing, basketball, football, make-up, or whatever is particularly rewarding... A recent example that is fresh on my mind was being given the opportunity to relate the use of N_2O to a drag racing enthusiast as a means of increasing the amount of oxygen in the engine. Suddenly, our learning about combustion reactions had a whole new importance for him. This knowledge suddenly became personally relevant and worth his effort to apply himself to the learning.

Teacher-in-Residence Profile: Dale Freeland

By Gabriel Popkin



Dale Freeland from Portage Central High School served as PhysTEC site Western Michigan University's first Teacher-in-

Residence, in 2002-2003. He started his teaching career in the rural setting of Paw Paw, Michigan in 1973, and moved to Portage Central High School in 1993, where he teaches physics and computer electronics. He has been an AAPT Physics Teacher Resource Agent since 1987 and has a long history of working with teachers in science education as an adjunct professor at Western Michigan.

Dale's teaching philosophy could perhaps be stated in three words: "learning is doing." Never satisfied to "let the chalk do the talking," he insists on having his students build real circuits, not just draw circuit diagrams, and fire actual projectiles, rather than just draw vectors on the board. (How many students do you know who have shot an apple off the school superintendent's head?) Dale has used a cell phone camera to take video and analyze the collapse of balsa wood bridges under pressure, and he has built a fuse demonstrator to show students who had never seen a fuse before how they actually work. During his year in residence at the Western Michigan, Dale's experience with demonstrations and inquiry-based

labs provided a valuable reality check for university faculty. After he heard a professor give a traditional lecture on resistors and capacitors, Dale produced a 1-Farad capacitor, a flashlight bulb, and 2 D-cell batteries, and, much to the professor's surprise, demonstrated the time constant of an RC circuit.

As Teacher-in-Residence, Dale was also instrumental in developing a mentoring program for future secondary teachers, and in establishing and maintaining contact with prospective teachers as they progress through their education. Since returning to the classroom, Dale has stayed involved with the project, attending conferences and continuing to be a resource for new teachers in Western Michigan. As one first-year physics teacher at his school says, "we spent many nights a week for many hours working on physics—and it came out all right." That teacher later co-presented with Dale at local and state science teacher meetings. Another teacher who graduated from Western Michigan told the PhysTEC project director that Dale's mentorship helped keep her in teaching during her first years as the lone physics teacher in a small school. Dale's work truly demonstrates the impact a master teacher can have both on an institution that prepares teachers and on a widespread teaching and learning community.

PTEC-North Carolina Regional Workshop

By Monica Plisch

In his inaugural speech as President of the University of North Carolina (UNC) system, Erskine Bowles told the audience that "in the past four years, our 15 schools of education at the University of North Carolina turned out a grand total of three physics teachers. Three." He promised that the University would "recruit more teachers, train our teachers better, and...mentor those teachers."

The PTEC project and UNC PhysTEC site leader Laurie McNeil responded by organizing a regional workshop in Chapel Hill, North Carolina, on August 3rd, 2007. Forty-five physics faculty, education faculty, and administrators attended, representing 14 of the 16 UNC campuses. The program featured several of the best-known physics teacher educators around the country—all of whom have been closely involved with the PhysTEC and PTEC projects.

The workshop ended with an intensive two-hour collaborative session in which participants developed plans for action at their own campuses. Three of the UNC schools followed up by sending representatives to the PTEC-sponsored Learning Assistant workshop in Boulder, Colorado. Meanwhile, PTEC is developing plans for another regional workshop to take advantage of the political momentum developing in California behind science and math teacher education.



Eugenia Etkina speaks about Pedagogical Content Knowledge at the PTEC-North Carolina Workshop in August 2007. Photo by Warren Hein.

Teacher Education: The Big Picture

By Ted Hodapp

The National Academies' *Rising Above the Gathering Storm*, published in 2005, focused the nation's attention on the shortages of science and math teachers in a way that few previous reports had. The momentum this report generated led to a number of significant events in 2007:

- This past fall the U.S. Congress passed, and President Bush signed into law, the America COMPETES Act (Pub. L. 110-69), a broad authorization bill aimed at improving American competitiveness. Among the specifications of the bill were substantial increases in funding for the National Science Foundation (NSF), and particularly programs within the NSF that address teacher education. While the debates over the 2008 budget between Congress and the President have delayed funding for some of the America COMPETES initiatives, it is safe to say that national attention continues to be focused on improving science and math teaching.
- The Congressional conference language for the NSF's Noyce Teaching Scholarships stipulated a 2008 appropriation of \$15M, but NSF chose to allocate only \$10.8M to this program for this budget year. While this is disappointing, pressure continues to be placed on this critical issue. A number of changes have also been suggested, including increasing the number of years of potential support for students, possible salary stipends during the years of service, and collaborative funding with outside sources. Congress is clearly showing significant interest in improving and expanding this program.
- This past fall the National Math and Science Initiative (NMSI), funded primarily by ExxonMobil, selected twelve sites to replicate the University of Texas at

Austin's successful UTeach program. These five-year, \$2.4 million awards will help transform these institutions' teacher education programs by facilitating strong collaborations between Colleges of Science and Education, providing potential teachers with early teaching experiences, engaging master teachers in designing and operating the program, developing a compact degree plan for four-year graduation with certification, and building a substantial endowment to sustain the program beyond the initial funding.

- In 2007 the American Physical Society (APS) and the American Association of Physics Teachers (AAPT) adopted a statement endorsing doubling the number of undergraduates in physics in the United States. One of the main motivations behind this action was to increase the number of high school physics teachers. Both societies continue to strongly support the PhysTEC project, and each society continues to devote substantial resources to the project and to advancing its mission.
- Building on the success of the National Task Force on Undergraduate Physics, which issued the 2002 report on effective strategies to increase enrollment in undergraduate physics programs, the APS, AAPT, and AIP have formed a task force focused on teacher preparation issues. This group is charged with identifying nationally recognized programs of teacher education, as well as distilling elements of teacher quality that can be effectively measured. The task force's report, which is expected in the summer of 2009, will also provide recommendations for policies to improve teacher education programs throughout the country.

300 Departments Sign Joint Statement

By Monica Plisch

In 1999, the American Institute for Physics (AIP), the American Physical Society (APS), the American Association of Physics Teachers (AAPT), and four other physics-related societies endorsed a statement urging the physics community "to take an active role in improving the pre-service training of K-12 physics/science teachers," in order to "help create a scientifically literate public, capable of making informed decisions on public policy involving scientific matters" and "produc[e] the next generation of researchers, innovators, and technical workers." The PhysTEC and PTEC initiatives grew directly out of these societies' commitment to engage physics departments in

addressing the critical teacher shortages around the country.

In January 2008, the number of physics departments endorsing the joint statement topped 300, out of a total of 767 degree-granting physics departments in the United States. Among the signees are Cornell, Harvard, MIT, Princeton, Stanford, and other notable leaders in the physics community. We are pleased by the physics community's broad commitment to preparing the next generation of physics and physical science teachers.

The full statement and list of endorsees is available at www.aps.org/programs/education/future-teachers.cfm.

Teacher Preparation Quiz

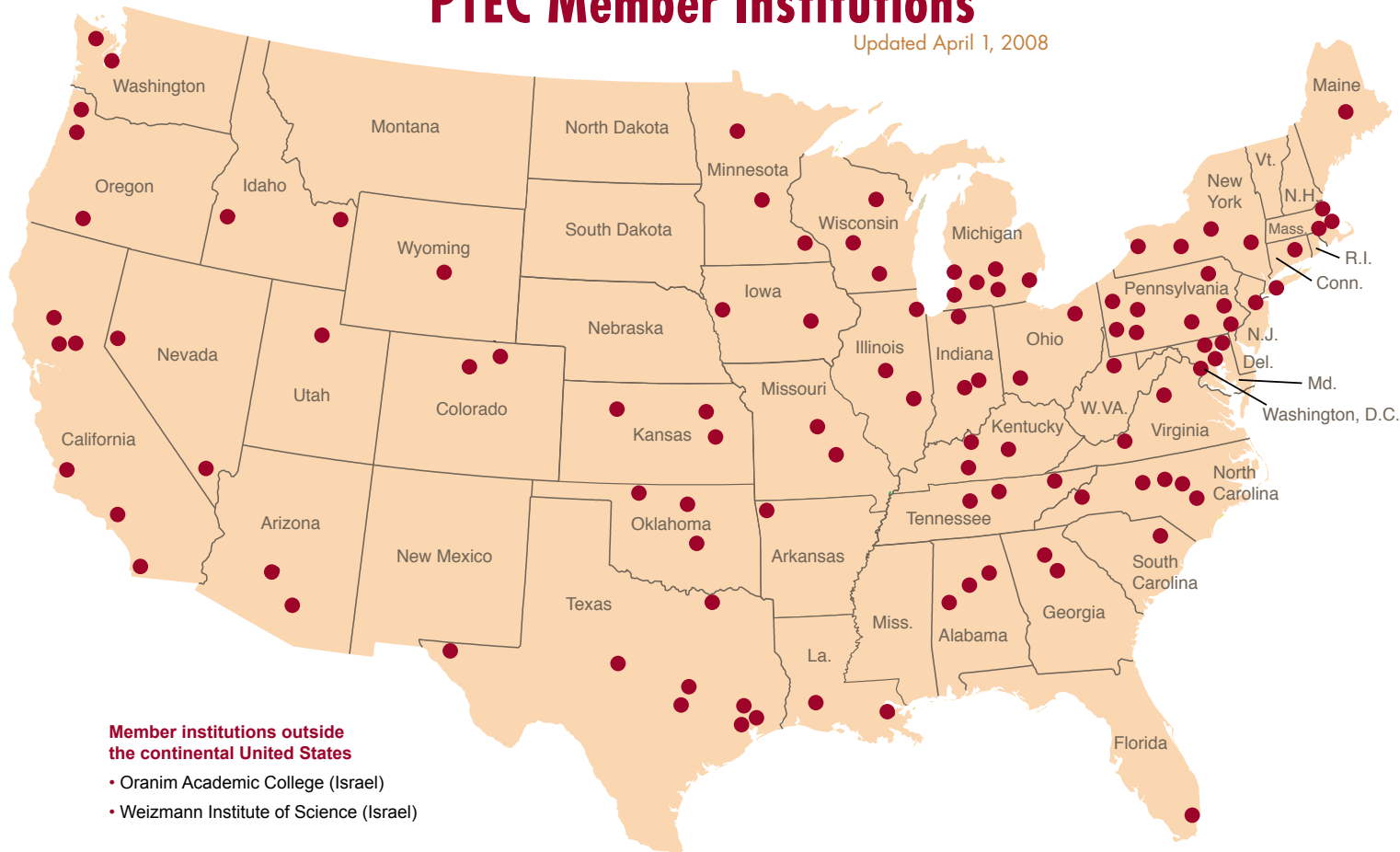
How much do you know about high school physics teaching? See if you can answer these questions:

1. How many U.S. high school students take physics each year?
2. What percent of all high school students in the U.S. take a physics course before they graduate?
3. What percent of the students taking physics take honors or advanced classes?
4. How many new physics teachers do U.S. schools hire each year?
5. What percent of these teachers have a physics or physics education degree?
6. How many U.S. students receive physics bachelor's degrees each year?
7. What percent of these went directly into teaching?
8. What was the top reason these teachers cited for deciding to become a teacher?

For answers, see www.phystec.org.

PTEC Member Institutions

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For a complete list of PTEC members, please see www.ptec.org/programs.



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