Executive Summary

This report documents the activities of the Physics Teacher Education Coalition (PhysTEC) project in the first year of its second round of funding (August 1, 2009 to July 31, 2010). The mission of PhysTEC is to improve and promote the education of future physics and physical science teachers. Specifically, the project aims to

- Demonstrate successful models for
  - Increasing the number of highly qualified high school physics teachers;
  - Improving the quality of K-8 physical science teacher education;
- Spread best-practice ideas throughout the physics teacher preparation community;
- Transform physics departments to engage in preparing physics teachers.

PhysTEC is a partnership between the American Physical Society (APS) and the American Association of Physics Teachers (AAPT). The project is funded primarily by the National Science Foundation, and has also received significant funds from the APS’s 21st Century Campaign, as well as direct and in-kind support from each of its partner institutions.

PhysTEC-funded institutions are selected colleges and universities that are developing their physics teacher preparation programs into national models with substantial project support. Five newly selected institutions will begin funding in Fall 2010, bringing the total number of funded sites to 17. Funded institutions have achieved a number of significant successes, including:

- Increasing the number of physics and physical science teachers graduating from their programs;
- Providing prospective teachers with early teaching experiences;
- Using master teachers to provide critical mentoring support to new graduates and develop bridges between physics departments, education schools, and local K-12 school districts;
- Transforming science and teaching methods courses for future teachers;
- Securing institutional resources to sustain program components;
- Disseminating results through publications and presentations at conferences and workshops;
- Raising the profile of teacher preparation efforts in the physics community.

The project also includes the Coalition Member Institutions (currently also known as PTEC Institutions), which as of this writing number 185. The project organizes an annual national conference, as well as smaller regional and topical workshops. In addition, the project has teamed up with ComPADRE, the NSF-funded digital library, to produce the PTEC website, which houses a collection of electronic resources for teacher preparation.

The project disseminates its results and reaches out to the physics community in a variety of ways, including newsletters, brochures, websites, videos, articles in a number of venues, activities at prominent national meetings, and regular status reports. The project has launched two additional major research and dissemination efforts: the national Task Force on Teacher Education in Physics, and a book of collected papers on teacher preparation. Project leaders are also seeking to magnify the project’s impact through collaborations with other organizations.
1. Results

The PhysTEC project can report significant findings and results. PhysTEC sites—insti- tutions with significant project support that have developed model teacher education programs (see Section 2)—represent about 1.5% of the institutions that offer physics majors, yet currently graduate approximately 8% of all new high school teachers of physics. The number of teachers graduating each year from PhysTEC institutions has greatly increased since the project began in 2001. The project has current employment information for nearly 80% of these teachers, of whom over three-quarters are teaching in a K-12 school. PhysTEC sites have also improved the preparation of about 500 elementary teachers per year through implementation of research-based curricula in physical science courses that these teachers take. Sites have developed and refined models of recruiting, course transformation, early teaching experiences, induction, and mentoring. Teachers-in-Residence and Teacher Advisory Groups have helped to create authentic collaborations among physics departments, education schools, and local school districts.

Because of the great need for highly qualified secondary physics and physical science teachers in the U.S., the PhysTEC project focuses primarily on recruiting and preparing more of these teachers. Of all sciences taught at the secondary level, physics has the greatest shortage of qualified teachers: only a third of the 23,000 high school physics teachers in the U.S. completed a physics or physics education major. The severe shortage of qualified high school physics teachers is confirmed by superintendents and principals, who rate physics teachers as the science or mathematics professionals that are the hardest to recruit. The shortage of physics teachers is only getting more critical, as the percentage of students taking physics in high school is increasing by approximately 1% per year. In addition, many states such as Texas have adopted laws requiring students to take four years of science. Legislation of this type, while addressing the need for a technologically literate workforce and citizenry, begs the question of who will teach these students. The consequences of the shortage of secondary physics teachers showed up strongly in the results of the third Trends in International Mathematics and Science Study

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2 Neuschatz et al.
4 Neuschatz et al.
(TIMSS), where US high school graduates underperformed in physics relative to nearly all other countries surveyed.  

1.1 Secondary Teacher Graduation Rates
PhysTEC institutions committed to increasing the number of graduating physics teachers have been successful in meeting that goal. While the absolute numbers may seem small, they indicate the potential impact PhysTEC reforms could have if implemented broadly. Each year, U.S. schools hire about 1200 new physics teachers, and only about 400 of these have a physics degree. By contrast, every PhysTEC teacher is required to have a physics major, minor, or equivalent content preparation, and must have completed a teacher preparation program. If a significant fraction of the nearly 800 institutions that grant a physics bachelor's degree make similar increases to those made at PhysTEC institutions, this will answer the need for the number of qualified physics teachers in the nation’s classrooms. As a symbol of the importance of its graduates, PhysTEC has prepared certificates for all 2010 graduates with signatures of the APS and AAPT presidents.

1.1.2 Early Careers
Most graduates of PhysTEC programs go into K-12 classrooms, where they have an opportunity to make a difference in the lives of many students each year. As a result of effective tracking of graduates, the project can report early career outcomes on nearly 80% of PhysTEC graduates from years one through six of the project. As shown in the graph, 77% of these graduates are currently teaching in K-12 schools or seeking teaching employment, and another 2% are teaching at the college level. Most are teaching physics and/or physical science. Other commonly taught subjects include math and chemistry.

1.2 Retention
Recent studies suggest that a significant fraction of teachers leave the profession within their first five years. Because the craft of teaching takes many years to master, it is critical not only to

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7 Ball State University already graduates more physics teachers than any other institution in Indiana, and focused on improving middle school teacher education and building mentoring programs rather than recruiting more physics teachers. Towson focused its first project exclusively on elementary teacher education. The other five PhysTEC Institutions not shown on the graph (Cornell University, Florida International University, University of Minnesota, University of North Carolina, and Seattle Pacific University) began projects in 2006 or later, and data on numbers of physics teachers educated are not yet available.
8 Neuschatz et al.
9 Neuschatz et al.
prepare teachers well, but also to support them so that they remain in the classroom. To address that need, PhysTEC institutions have provided mentoring to around two-thirds of their teacher graduates, most of it by highly respected and experienced high school master teachers, or Teachers-in-Residence (TIRs). Eighty-six per cent of PhysTEC graduates who went into teaching completed three years in the classroom\(^\text{11}\); nationwide, according to a US Department of Education survey, this number was 78\% for all teachers.\(^\text{12}\)

1.3 Elementary Teacher Preparation
PhysTEC recommends that institutions that prepare elementary teachers adopt research-based science curricula such as *Physics and Everyday Thinking (PET)*\(^\text{13}\), *Physics by Inquiry (PbI)*\(^\text{14}\), and *Powerful Ideas in Physical Science (PIPS)*\(^\text{15}\) in their physical science content courses for these teachers. At Cal Poly San Luis Obispo, Seattle Pacific University, Towson University, University of Arkansas, University of Colorado at Boulder, and University of Minnesota, a course using one or more research-based curricula is required or recommended for all elementary education majors; at Arkansas, PhysTEC funded the initial implementation of PET. In addition, Towson completed a major reform of its elementary field experience course (see Section 2.2). PhysTEC sites now graduate about 500 elementary teachers per year who have taken at least one reformed science or methods course; in total, PhysTEC has improved the preparation of over 4,000 elementary teachers.

1.4 Key Components
The PhysTEC project recognizes that successful teacher preparation programs share certain interrelated key components. These activities and programs build on one another to provide teachers with a complete educational experience, from recruitment through training in pedagogy and content to induction and mentoring. This report will briefly discuss the components here; for greater detail and links to strategies and resources for implementing each one, see www.PhysTEC.org/components.

1.4.1 Recruitment
A strong recruiting effort begins the first day of classes, with faculty members, Teachers-in-Residence, and future teachers visiting introductory courses—both in the physics department and in related areas such as engineering or applied physics—to promote the teaching profession and inform students whom to contact for more information. The introductory physics course is also often an excellent recruiting tool, when taught by an instructor who can model excellent teaching and engage his or her students. Most PhysTEC sites have added undergraduate peer teachers called **Learning Assistants** to make their introductory classes more collaborative, student-

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\(^\text{11}\) This represents 37 out of 43 teachers who graduated at least three years ago and on whom the project has data.


centered, and interactive. A strongly supported early teaching experience such as a Learning Assistant program can excite students who hadn’t previously considered a teaching career. And personal relationships are always critical—successful teacher preparation programs thrive on excellent advising and mentoring both during and after a teacher’s formal education.

Effective teacher recruitment also depends on creating a program that encourages and supports future teachers throughout their education. The University of North Carolina has created a degree program that provides undergraduates a physics major and teaching certification in four years. A number of other PhysTEC sites such as Arkansas and Seattle Pacific University have created alternative degree and certification plans that allow students flexibility in completing their education. Scholarship support can also be critical, as future teachers and their parents know they will not likely be earning large salaries as classroom teachers. A number of PhysTEC sites have received awards through the NSF’s Robert Noyce Teacher Scholarship Program to provide scholarships to future math and science teachers, in exchange for a commitment to teach in a high-need school after graduation.

In Fall 2008, the PhysTEC project received its own award through the Noyce program, to support future physics teachers at six PhysTEC institutions. This is the first Noyce award to focus on a single science discipline, as well as the first given to a professional society (APS and AAPT jointly run the PhysTEC Noyce). For the 2010-2011 academic year, fourteen students from five PhysTEC institutions received Noyce scholarships. Of these, five are returning scholars, and nine are new applicants. Eight will be post-baccalaureate students and six will be seniors in 2010-2011. They will join four additional scholars who received awards in 2009-2010. More information about the PhysTEC Noyce Program is available at www.PhysTEC.org/noyce.

The project has also embarked on a marketing campaign to help sites promote physics and teaching to students who previously have not been engaged in these areas. Project leaders have gathered ideas from the University of Texas at Austin’s UTeach math and science teacher preparation program, and are developing a plan with John Rice, a marketing expert who helped Louisiana State University design a highly successful marketing campaign for its GeauxTeach program, which is based on UTeach. PhysTEC set up visits for Rice to Florida International University and the University of North Carolina in Fall 2009, and Rice is in the process of working with these universities to develop materials to recruit more teachers, as well as more physics majors. Project leaders hope these efforts will enable all sites to tap new sources of potential majors and teachers.

The project has also developed several videos intended to help universities recruit physics teachers. These videos are freely available on the web to all universities.

1.4.2 Early Teaching Experiences
Most first-year college students do not have well-formed career plans, and those who think they do may change them many times before they graduate. A well-designed early teaching experience can give freshmen or sophomores a low-pressure taste of the rewards and challenges of teaching. They may be surprised at how much fun they have, and how much they learn. PhysTEC views early teaching experiences as an important step along the teacher preparation continuum that begins with recruitment and continues into the first years of a teacher’s career.
Project sites have offered a variety of early teaching experiences. Some have created programs that place preservice teachers into local public school classrooms early on, while others have created in-house early teaching experiences in the form of Learning Assistant programs, which allow students to teach their peers in undergraduate physics courses.

1.4.3 Learning Assistants
The Learning Assistant model was developed independently at several PhysTEC sites, most notably the University of Colorado at Boulder. Learning Assistants are talented undergraduates who work with faculty members to make large-enrollment courses more collaborative, student-centered, and interactive. Learning Assistant programs provide potential future teachers with strongly supported and low-stress early teaching experiences that can encourage them to pursue teaching certification. In many cases, these potential teachers can be unsuspecting students who discover an interest in teaching. Thus, a Learning Assistant program broadens the pool of potential future physics teachers. Learning Assistants also enhance their content knowledge through the process of teaching course material, and data from Colorado show that Learning Assistants can improve learning gains of students in classes that use them.\(^\text{16}\)

The specific roles that Learning Assistants take on can vary between courses, but all programs share certain features that distinguish them from more conventional teaching assistantships:

- Learning Assistants for a particular course are recruited from among the top undergraduates who recently completed that course;
- Concurrent with teaching, Learning Assistants participate in a pedagogy course that introduces them to interactive teaching techniques and education theory;
- Learning Assistants are encouraged to enter a teacher certification program, and at many institutions are required to do so if they wish to continue serving as Learning Assistants for multiple semesters.

All four of the currently funded PhysTEC sites as well as four out of eight of the legacy sites have active Learning Assistant programs, and the idea is spreading beyond the PhysTEC community. In October of 2007, the project sponsored a two-day workshop at the University of Colorado at Boulder for faculty from Coalition institutions. (See also Section 3.1.2.3) A large fraction of the applicants to last fall’s request for proposals included Learning Assistant programs in their applications, including all five of the selected sites.

1.4.4 Course Transformation
The PhysTEC project encourages funded institutions to teach introductory physics courses that use interactive engagement methods shown to improve student learning. These courses also serve to model effective teaching practices and often involve more advanced students as Learning Assistants, who have taken the course previously and who guide their peers to a greater understanding of physics concepts. PhysTEC has encouraged its sites to adopt proven curricular

reforms because 1) PhysTEC understands that teachers teach as they have been taught; 2) these reforms have been shown to improve learning gains on standardized, research-based content assessments of conceptual understanding\textsuperscript{17}; and 3) the high-quality, research-based materials have been carefully designed to avoid many pitfalls that home-cooked curricula may fall into.

The hope and expectation is that students whose instructors use effective interactive teaching methods will go on to use these same methods when they become teachers.

PhysTEC impacts far more students than just those who complete a teacher preparation program. In Arkansas project leader Gay Stewart’s words, “University of Arkansas’s philosophy has been that you never know who is going to be a future teacher, so you should treat all students as if they might be, modeling good pedagogy in introductory physics classes. This has the beautiful side effect that if all students experience an intro class taught the way we would like future teachers to teach, you end up with more MAJORS!” Over 20,000 students have taken reformed courses in algebra- and calculus-based physics at PhysTEC institutions, and over 4,000 students have taken PhysTEC-influenced courses in elementary or secondary pedagogical methods. These numbers are especially important as many STEM students become teachers as a second or third career, or help educate future teachers. All of these students will engage in teaching at some point in their lives, whether as a parent, a work colleague, an informal mentor, or in other ways, and improving their attitudes toward science and science education will have a ripple effect in more ways than it is possible to measure.

1.4.5 Teachers-in-Residence

Over the course of the project, 48 Teachers-in-Residence (TIRs) have served at PhysTEC institutions. TIRs are master teachers whom PhysTEC sites “borrow” from a local school for a year, to help build bridges between the physics department, the education department, and the local school district. TIRs can also strengthen ties between theory and practice by sharing their expertise and classroom experiences with pre-service teachers. A TIR can take on many roles, depending on the needs of the institution. TIRs have recruited new teachers, mentored pre-service and beginning teachers, taught methods and content classes, redesigned existing course curricula, developed new courses, and given workshops and presentations at local, regional, and national meetings, including AAPT, National Science Teachers Association (NSTA), and PhysTEC conferences. After their service in the project, 69% of TIRs who were employed as teachers immediately before beginning their TIR year went back to the classroom, providing PhysTEC sites with valuable contacts in their local school systems. Several PhysTEC institutions, including Arkansas, Cal Poly, Florida International, and Towson, have dedicated institutional funds to sustain a TIR position after project funding ended. Seattle Pacific funds a TIR through a grant from the Boeing Corporation, and this individual participates in PhysTEC activities and interacts frequently with project participants.

Seattle Pacific also used part of its PhysTEC funds to hire a “Visiting Master Teacher” (VMT). The VMT is a part-time position that fills some of the roles of a traditional TIR. Based on the SPU model, the project is offering funding for VMTs at PhysTEC Noyce sites, to provide

mentoring and support for Noyce scholars when they become teachers. The VMT may also be an especially important model for smaller institutions.

Examples of roles played by TIRs in the PhysTEC project include:

- Leadership in recruitment efforts, including classroom visits, development of recruiting materials, and individual interactions;
- Development and teaching of pedagogy courses for Learning Assistants and future teachers;
- Coordinating and overseeing Learning Assistant programs;
- Advising and mentoring students within the program as well as teachers who have graduated from the program;
- Developing collaborative relationships between the physics department, education school, and local school districts;
- Providing professional development workshops and courses on inquiry-based teaching;
- Giving talks at national meetings such as AAPT and NSTA;
- Writing articles for publication in venues such as the *APS Forum on Education Newsletter*;
- Assisting with student teaching placements.

Each summer, TIRs from past years contribute to the induction session of the new round of TIRs and pass along valuable knowledge and experience. Because it is the largest investment of the project, PhysTEC leaders have recognized the importance of “making the case” for TIRs and communicating the unique value they provide to a teacher preparation program. For this purpose, the project assessment team has developed a TIR interview protocol and is planning a large-scale study of the TIR component of the project, which will be published in a suitable venue.

### 1.4.6 Induction and Mentoring

Teacher education does not end at graduation. PhysTEC institutions provide critical mentoring and induction support during the first years of teaching, which has been shown to improve retention rates of new teachers. In 2007-2008, most PhysTEC teachers in their first and second year of teaching were mentored by TIRs. In addition, PhysTEC TIRs provided mentoring to other new physics teachers located near PhysTEC institutions. In this way, mentoring is an important mechanism through which PhysTEC has been able to reach out to local K-12 communities. The graph below shows the growth of mentoring during the PhysTEC project.

![PhysTEC Mentoring Activities Graph](image)

*Not all sites reporting data. In addition, some legacy sites have not been able to sustain the TIR beyond PhysTEC funding, leading to a decrease in mentoring activity at these sites.*

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The project has collected testimonials from individuals whose lives were touched by the project. One TIR’s mentee wrote: “You have always been a positive light in what has otherwise been a bleak time. Through all the stressful times and deadlines, you are a constant reminder of how a teacher should treat their students. I want to be just like you when I grow up. You rock!!!”

Another mentee wrote, “After I got my first teaching job PhysTEC became even more important. I was teaching in a rural school where I was the ‘expert’ in physics and chemistry. I had a lot of questions that first year and my mentor [assigned by the] school helped me out, but it was the connections I made before that which seemed to help me out even more.”

1.4.7 Teacher Advisory Group
Many PhysTEC sites have recruited local physics teachers to form Teacher Advisory Groups (TAGs), which can advise faculty on how to improve their teacher preparation programs. TAGs typically also become communities where teacher networks form, and where pre-service teachers can meet and learn from experienced working teachers. Several PhysTEC teachers were initially recruited through connections they made with a practicing teacher. Often these relationships lead to TAG teachers facilitating and hosting field placements for student teachers. TAGs have also been good sources of TIRs for PhysTEC institutions. The project has offered funding for TAG development to PhysTEC Noyce sites.

1.4.8 Collaboration
PhysTEC encourages physics departments, education schools, and local school districts to work together to create coherent and logical course sequences and teaching experiences leading to teacher certification. Collaborating physics and education faculty at a number of sites have been able to reduce the course burden on their future teachers and allow certain courses to be counted toward both the physics degree and teaching certification. In some cases, such as North Carolina, this enables teachers to complete their undergraduate majors with certification in four years, thereby reducing the cost of their pre-service education. A strong alliance with members of the College of Education has also helped Florida International site leaders bring science teacher preparation into the disciplinary departments. A number of sites have submitted joint physics-education grant proposals, including Noyce proposals that support future teachers. Colorado went one step further by becoming a UTeach replication site, which requires a very high degree of interdepartmental collaboration in order to implement a complex math and science teacher preparation program based on the model developed at the University of Texas at Austin.

The linchpin of collaborative efforts at many PhysTEC sites has been the Teacher-in-Residence. Several TIRs have developed and co-taught science methods courses with education faculty members, supplying a wealth of real-life classroom experience and physics content knowledge. The TIR is also in a unique position to use his or her connections in the local school district to improve the preparation, induction, and mentoring of future physics teachers, often through a Teacher Advisory Group.

1.4.9 Assessment
PhysTEC leaders recognize the need to gather data on the project, both to determine whether it is effectively carrying out its goals and to support broader dissemination and advocacy efforts. PhysTEC has therefore undertaken a comprehensive assessment effort, in order to fully evaluate
its impact both on classroom teachers and on institutions around the country. The project is evaluating its success through

- the career outcomes and retention rates of teachers who graduate from funded institutions;
- the preparation and effectiveness of teachers who graduate from funded institutions, using content knowledge assessment of both the undergraduate courses these teachers take and the secondary courses they later teach; and
- the extent to which the project has catalyzed institutional transformation leading to sustainable teacher preparation programs.

In addition to project-wide summative assessment, PhysTEC recognizes the importance of formative assessment, in particular as it relates to a teacher’s education. Both content and pedagogy assessment instruments are used to show areas in which pre-service and new in-service teachers are strong, and areas in which they need to improve. Formative assessment is an especially powerful tool in the context of a mentoring relationship. In 2010-2011, the project will be contracting with a consultant to do project-wide formative assessment as well as receiving feedback from our Advisory Committee.

1.4.9.1 Career Outcomes and Retention

The project collects data annually from all sites on current and past graduates, including contact information, degrees and certifications, and employment information. This year, recognizing the vital importance of tracking teachers and their careers beyond graduation, the project also contracted with the AIP’s Statistical Research Center to design a survey for PhysTEC graduates, based on the quadrennial survey given to high school physics teachers around the country. This survey is in progress, and results from it are expected later this summer. This will be the project’s most thorough attempt to gather data directly from graduates.

1.4.9.2 Content Assessment

PhysTEC institutions use research-validated instruments including the Force Concept Inventory (FCI)\(^{19}\) and Conceptual Survey of Electricity and Magnetism (CSEM)\(^{20}\) to assess student learning at PhysTEC sites and ensure that course reforms are effective. The graph below shows normalized learning gains for courses at PhysTEC sites, both before (“Traditional”) and after (“Transformed”) reforms were implemented. The normalized learning gain \(g\) is calculated according to the formula:

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g \equiv \frac{\text{gain}}{\text{possible gain}} = \frac{\text{post} \% - \text{pre} \%}{100\% - \text{pre} \%}
\]

Learning gains approximately doubled at many sites as a result of PhysTEC-supported course reforms. Learning gains on the FCI were nearly identical to published data for “interactive engagement” instruction\(^{21}\), indicating a high degree of fidelity in implementing course reforms.


\(^{21}\) Hake.
The strong performance of PhysTEC students on content assessments provides evidence that PhysTEC teachers are receiving good content preparation in physics.

More recently, the project has taken content assessment to the next level, by working with PhysTEC teachers in the classroom to give the FCI to their students and provide data to the project for analysis. In 2008-2009, seven PhysTEC teachers agreed to give the assessment and provide data to the project, and in 2009-2010, eleven teachers participated. Along with FCI pre-test and post-test scores, the project is collecting information from teachers on the school and classroom context in which they are teaching. As of this writing, 2009-2010 data are still being analyzed. Due to the small number of teachers who have completed the study so far, the project is not yet able to draw any conclusions from data collected in 2008-2009.

1.4.9.3 Sustainability
While PhysTEC institutions have achieved impressive successes, they will do little to address the long-term issues of teacher shortages and teacher quality if they do not live on beyond the lifetime of external funding. Therefore, the project has sought to catalyze systemic, long-term change at the departmental and institutional level. PhysTEC faculty have succeeded in making permanent many of the initiatives originally supported by project funding, including TIRs, Learning Assistant programs, and new and reformed courses. Their programs now serve as models of change for departments and institutions around the country that are seeking to improve their teacher preparation programs. Specific examples of sustained programs at individual sites can be found in the program descriptions below.

Project leaders have developed plans for a study on sustainability that will include four “legacy” PhysTEC sites that have ended their funding period. Project leaders and an assessment consultant will visit each site and determine to what extent project reforms are being carried on post-funding, and what conclusions can be drawn more generally about sustainability of teacher preparation efforts.

1.4.9.4 Advisory Committee
The project has engaged an external advisory committee to provide a broader perspective on the project’s context and activities. The committee is composed of a diverse group of senior members of the science and education disciplines, who will meet once annually for two days to learn about the project and provide guidance to project management on ongoing activities and future directions. The new advisory committee will meet for the first time in Fall 2010. For a list of current and original advisory committee members, see Appendix 3.
2. PhysTEC Institutions

PhysTEC institutions are selected colleges and universities actively engaged in science preparation of future teachers with substantial project support. They are chosen based on their potential to both make substantial increases in the number of teachers they graduate, and to develop programs that will serve as national models. At the time of this writing, there are five sites joining the project, four sites transitioning off funding, and eight “legacy sites” that have completed their main funding period, and are now supporting teacher preparation activities independent of PhysTEC. These institutions remain in close contact with the project, provide advice to currently funded sites, and continue to provide data necessary to assess the impact of the project.

Project leadership communicates with funded sites in a variety of ways, including annual 1.5-day site visits, frequent phone conversations, mid- and end-of-year reports, and meetings of all site leaders at the annual PhysTEC Conference and the AAPT Summer Meeting, typically in late July. The biannual project meetings provide an important opportunity for site leaders to share successes and challenges and to learn from each other. In addition, project management often invites leaders from one site on a visit to another site, when an opportunity for collaboration and synergy presents itself. In this way, the project is more than the sum of its parts, as innovations at one site are frequently adopted at other sites.

The following table lists all PhysTEC institutions.

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<thead>
<tr>
<th>Institution</th>
<th>Location</th>
<th>Project Term</th>
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<tbody>
<tr>
<td><strong>Institutions Beginning Funding Period</strong></td>
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<tr>
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<tr>
<td>Xavier University of Louisiana***</td>
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<td>2001-2005</td>
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*Towson University’s first PhysTEC project focused on elementary teacher education. Its second project will focus on secondary teacher education.** Due to changes in faculty at Oregon State, there did not exist a commitment by the department to engage in the project at the depth required in year three. Consequently, a joint understanding was reached prior to year four to suspend Oregon State as a PhysTEC institution. Project leader Theodore Hodapp visited the department in the Fall of 2004 and held discussions with the department about the possibility of rejoining. Since departmental staffing was still in considerable flux, it did not seem appropriate to pursue rejoining the project. Oregon State remains a Coalition member.*** Owing to the tremendous hardships and difficulties associated with rebuilding Xavier University of Louisiana’s program in the wake of Hurricane Katrina, Xavier asked for and was granted permission to suspend activity on the project for the 2005-2006 funding year. As of the drafting of this report, Xavier has not sought to restart project activity. Xavier remains a Coalition member.

### 2.1 Institutions Beginning Funding Period

In October 2009, PhysTEC solicited applications for new PhysTEC sites that would receive up to three years’ worth of funding. The review process was modeled after that of the NSF, with a two-stage application procedure and a panel of reviewers. The project invited proposals in two categories—Comprehensive Sites that would be funded at up to $100k/year to engage in a full range of PhysTEC activities, and Pilot Sites that would be funded at up to $25k/year to focus on specific aspects of improving their teacher education program. The Request for Proposals was announced on the web, in *APS News*, on project email lists, and in a mailing that went to all physics department heads in the country. In addition, project leaders traveled to California to meet with two groups of universities and two-year colleges with the goal of catalyzing fundable collaborations. The project director also conducted significant outreach to minority-serving institutions, calling many of them and meeting with representatives of the National Society for Black Physicists to discuss the possibility of a consortium of Historically Black Colleges and Universities applying for funding.

Ultimately, 52 institutions applied to the first round—26 as Comprehensive Sites and 26 as Pilot Sites. Thirteen applicants—seven Comprehensive and six Pilot—were invited to proceed to the second round of the application, and all submitted the secondary application materials. At the end of the review process, the project decided to invite California State University, Long Beach; Chicago State University; Middle Tennessee State University; Towson University; and the University of California, Davis join the project. These sites will begin their projects in August 2010, and will be supported by funds from the NSF.

**California State University, Long Beach** (CSULB) is a large comprehensive university located in the Los Angeles metropolitan area, with a population of nearly 38,000 students. CSULB prepares 6% of California’s secondary science teachers, as well as a large number of pre-secondary teachers, and is recognized as a Hispanic Serving Institution. The university has a Science Education Department situated within the Physics Department in the College of Natural Science and Mathematics, and this department has hosted several funded projects to support
future science teachers, including a Robert Noyce Teacher Scholarship program. The CSULB PhysTEC project aims to increase the number of physics majors earning teaching credentials at CSULB by active recruiting, early teaching experience opportunities, and continuing support structures for all levels of teachers. Participating students will be identified as “PhysTEC Scholars,” and will participate in a Learning Assistant program as well as courses designed to provide early teaching experiences and physics discipline-specific teaching methodology.

**Chicago State University** (CSU) is a public, urban, minority-serving institution serving approximate 7,000 undergraduate and graduate students on the South Side of Chicago. Because of CSU’s location and environment, support from PhysTEC has the potential to increase the number of students of color entering the science teaching profession and teaching in high-need area schools. The Department of Chemistry and Physics has 17 full-time faculty members, two of whom primarily conduct research in science education. Future teachers in the CSU PhysTEC Program will be involved in a number of existing courses and outreach opportunities that promote active engagement and group work. Project leaders will focus on recruiting efforts to bring more teachers into the program; in addition, project leaders plan to develop a “teacher immersion institute” that will enable future teachers to work with inservice teachers. Students who decide to pursue secondary science education will also have the opportunity to apply for the Robert Noyce Teacher Scholarship and “Science Van” programs, as well as internships with external partners, which currently include the Museum of Science and Industry, the Chicago Field Museum, Adler Planetarium, and the Southeast Environmental Task Force.

**Middle Tennessee State University** (MTSU) is home to over 25,000 students in the geographic center of Tennessee, a state that has recently increased the number of science and math courses needed to graduate from high school. Responding to the challenge of preparing teachers to teach these courses, MTSU was recently named a replication site for UTeach, the national math and science teacher preparation program that began at the University of Texas at Austin. In addition, the president of the university has declared the goal of becoming the number one producer of Science, Technology, Engineering, and Mathematics (STEM) secondary education teachers in both the state and the Southeast region. The Physics and Astronomy Department is well poised to make major gains in educating teachers, having already put in place a requirement that all physics majors act as learning assistants, and having incorporated aspects of the Modeling Instruction Program into its curriculum. In addition, the department won a Robert Noyce Teacher Scholarship grant that will provide $850K in scholarship funds for future math and science teachers. Site leaders have also initiated a marketing effort to attract more majors, and future teachers, to the department.

**Towson University** is a public university in Maryland with a student population of just over 21,000. In an earlier project, PhysTEC funded Towson for four years (2004-2008) to reform the field experience course taken by elementary education majors to inculcate them with inquiry-based teaching techniques. Towson's new PhysTEC project will focus on secondary teacher education. Towson University is one of the few academic institutions to have a significant number of education faculty housed in its content departments, including five in the Department of Physics, Astronomy, and Geosciences. The department is in a strong position to begin its PhysTEC project, having already put in place a number of initiatives to increase student retention, including a freshman seminar, inquiry-based introductory courses, mentoring
opportunities, a Learning Assistant program, and scholarship opportunities, including a Robert Noyce Teacher Scholarship.

University of California, Davis (UC Davis) is a large, comprehensive public university located in the state’s Central Valley, a region where highly qualified teachers of physical science are in especially short supply. To help meet the needs of the state and the region, the campus has established the Mathematics and Science Teaching (MAST) program, which uses master teachers to provide students with early teaching experiences through three seminars that have concurrent field work in elementary, middle school, and high school classrooms. The program has also established a protocol for recruiting and advising prospective teachers and currently serves 400-500 students per year; however, very few physics teachers graduate from the program. The UC Davis Department of Physics has an active Physics Education Research (PER) group, and has carried out a number of PER-based reforms on its undergraduate curriculum. These include reforming its introductory physics series for biology majors, and to a lesser extent the track for physics majors, as well as the TA training for these courses. The department is also planning to add a teaching track to either its Physics or Applied Physics major, to capitalize on interest among its students in teaching.

2.2 Institutions Currently Receiving Funding
In October 2006, as in 2009, PhysTEC solicited applications for PhysTEC sites that would receive three years’ worth of funding. Forty-five institutions applied to the first round, and twelve were invited to proceed to the second round of the application, of which eleven submitted the secondary application materials. At the end of the review process, the panel recommended that Cornell University, Florida International University, the University of Minnesota, and the University of North Carolina at Chapel Hill join the project. These sites began their projects in August 2007, and are supported by funds from APS’s 21st Century Campaign. Florida International University is transitioning off funding in July 2010; the other three have signed or are planning to sign Memoranda of Understanding (MOUs) for another year, to use unspent project funds.

Cornell University’s PhysTEC project leaders recognize that relatively few Cornell physics students pursue teaching, and Cornell faculty have not traditionally promoted it as a potential career. As a result, the project has sought to raise the awareness and change the attitudes of students and faculty regarding careers in high school science teaching, provide opportunities for students to experience the challenges and rewards of classroom teaching, and provide mentoring and support as they work through the education
program and into their first years as teachers. Through targeted one-on-one conversations, Cornell TIRs have attracted record numbers of physics majors to School of Education recruiting sessions for future teachers. More broadly, Cornell site leaders report that the project has greatly improved the status of teaching careers in the physics department, among both students and faculty. Cornell’s Undergraduate Teaching Assistant (UTA) program (similar to a Learning Assistant program) launched with eight undergraduates in Spring 2008, and has expanded since then. Experienced UTAs can become Master UTAs, who mentor newcomers to the program. Three Cornell future physics teachers are in the first two classes of PhysTEC Noyce Scholars.

Florida International University (FIU) in Miami educates more Hispanic students than any other institution in the country, and that diversity is reflected among FIU’s physics majors. The site leader has built a thriving learning community within the department, based on the principles of Arizona State University’s Modeling Instruction Program, and has now expanded these efforts to include educating teachers. Project leaders launched a Learning Assistant program that has spread to the Math, Chemistry, and Earth Sciences departments, and now attracts over 100 applicants per semester. New Science and Mathematics Secondary Education Programs based on the Learning Assistant model were created in 2008-2009 and were made available to students in Fall 2009. In 2008 FIU graduated its first physics teacher in a decade, and more are in the pipeline. The university 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, which has one of the largest and most diverse school districts in the country.

University of Minnesota project leaders have developed a novel implementation of the Learning Assistant program, in which Learning Assistants work with small teams of students during lecture classes. In the first two years of the program, 60 Learning Assistants were hired to help with these classes, and there is significant interest within the university in looking at the Learning Assistant program as a means to improve retention of STEM majors. One Learning Assistant said “the experience encouraged me to stick with physics,” and that “If I hadn’t done the program, I don’t know if I would still be a physics major,” because it provided strong connections within the department and gave her confidence in her abilities. Content and attitudes assessments show improvement in courses using Learning Assistants versus those that do not. Minnesota is extending its PhysTEC MOU for a fourth year to hire a new TIR using internal funds that match project funds 3:1.

University of North Carolina at Chapel Hill’s (UNC) goal as a PhysTEC institution is to establish a program in which science majors prepare to become high school science teachers as they pursue their undergraduate degrees, and graduate in four years with teaching certification. This program, called UNC-BEST (UNC Baccalaureate Education in Science and Teaching), is a
partnership between the College of Arts and Sciences and the School of Education, which began with the Department of Physics and Astronomy and the Department of Biology. It has since expanded to Chemistry, Geological Sciences, and Mathematics. UNC-BEST’s first graduating class, in 2009, included one physics teacher—the first graduating from the school in at least a decade—and seven biology teachers. As part of the program, the UNC TIR worked with a Physics Education Research (PER) specialist to design a physics methods course for students interested in teaching. The project leader is planning to implement further reforms in introductory physics courses, including a classroom based on North Carolina State University’s NSF-funded SCALE-UP program. In addition, recognizing that the physics department’s relatively small number of undergraduate physics majors is hindering their ability to recruit more teachers, project leaders have engaged a marketing consultant to develop a campaign to recruit more majors, as well as teachers, to the physics department. The cost of this effort is shared between PhysTEC and UNC. Like Minnesota, UNC will extend its PhysTEC MOU to use unspent funds to hire a TIR for an additional year.

2.3 Legacy Institutions
The initial PhysTEC site solicitation occurred in 2001, and six institutions—Ball State University, Oregon State University, the University of Arizona, the University of Arkansas, Western Michigan University, and Xavier University of Louisiana—were chosen. Of those, four completed their funding term, while two left early for reasons outside the project’s control (See Table 1 for more information). Subsequently, three other sites—Cal Poly San Luis Obispo, Towson University, and the University of Colorado at Boulder—were selected for three-year funding terms. Each legacy site has made significant contributions to the project, and has sustained elements of their teacher preparation program beyond PhysTEC funding.

**Ball State University’s** PhysTEC project concentrated on improving its middle school science teacher education program, reforming the introductory algebra-based physics courses taken by future middle school physical science teachers, and developing an effective induction and mentoring program for newly certified physics teachers. As a result of Ball State’s mentoring efforts, the site achieved a 100% retention rate of physics teachers graduated during its PhysTEC funding period of 2001-2008, with 16 teachers graduating during this time. PhysTEC’s influence on the department can be seen in the hiring of a permanent PER faculty member and providing assistance to a doctoral candidate, who is an experienced physics teacher, to assume some of the roles that the TIRs took on during the course of the project. In addition, the PhysTEC TIR model has been used for new teacher induction and mentoring in Ball State’s recently awarded Woodrow Wilson National Fellowship Foundation program. Two Ball State future physics teachers were in the first class of PhysTEC Noyce scholars, and one received a second year of support.

**California Polytechnic State University, San Luis Obispo’s** PhysTEC project focused on developing and assessing sustainable course reforms, increasing collaboration with local school districts through a Teacher Advisory Group (TAG), and securing institutional funding for an on-campus TIR. Cal Poly now has one university-funded TIR, who has now completed her sixth year in the position, and plans are developing to hire another. Project leaders developed comprehensive daily planning guides for introductory calculus-based physics courses and the physical science course for elementary education majors, to allow interactive course reforms to
be sustained when transferred between instructors. Faculty and TIRs also worked with local teachers in the TAG to develop and evaluate observation instruments for use in the introductory pedagogy course.

**Seattle Pacific University (SPU)** began its funding period in 2006 and finished in 2009. SPU, a four-year liberal-arts institution with around 3,000 students, has the potential to serve as a model for teacher preparation programs at liberal arts institutions around the country. One innovation that came out of SPU is the Visiting Master Teacher, who is essentially a part-time TIR taking on a subset of the roles of the traditional PhysTEC TIR. Like many PhysTEC sites, Seattle Pacific has made the Learning Assistant program a cornerstone of its recruitment and early teaching experience strategy. The project leaders also work closely with several progressive school districts to provide robust, content-rich professional development for teachers. A strong spirit of collaboration exists between Seattle Pacific’s Physics Department and School of Education as well, exemplified by the transfer of an education faculty line to one that is split between these two units, and an interdisciplinary Science Education Task Force consisting of physics and education faculty. Three SPU future physics teachers were in the first class of PhysTEC Noyce scholars, and seven are in this year’s class.

**Towson University**’s original PhysTEC effort was unique within the project in that it supported only elementary science education. Towson graduates about 200 elementary education majors a year (more than any other school in Maryland), and its PhysTEC efforts focused on reforming its field experience course to foster inquiry teaching, maximize contact time with elementary students, and provide mentoring and opportunities for self-reflection. The Towson project was able to measure considerable progress in course structural reform efforts, future teachers’ attitudes towards science and science teaching, and, most importantly, teachers’ practice of inquiry science teaching. The deans from the College of Education and the College of Science and Mathematics have provided funding for a permanent staff position to take on TIR duties and other PhysTEC efforts that were made by project leaders.

**University of Arizona**’s PhysTEC program is built around its College of Science Teacher Preparation Program, and has graduated an average of two physics teachers per project year, up from one in three years pre-PhysTEC. The project leader has conducted extensive outreach to the local teacher community in developing the program, including establishing an active Teacher Advisory Group and involving teachers in curriculum development for pedagogy courses. Arizona’s program is now a well-established entity on campus that currently supports two adjunct instructor positions. The project leader has recruited a sizable community of area mentor teachers to provide early field experiences to pre-service teachers, a major component of Arizona’s teacher preparation program.

**University of Arkansas** has been spectacularly successful at recruiting physics teachers, increasing the number of graduates to more than 10 times what it was before the PhysTEC project began. The program develops student interest in physics with inquiry-based introductory courses (which recruit more majors as well as more teachers—see graph), guides potential teachers through the licensure process, and mentors them during their early careers. The university has also funded a TIR position in the College of Education and Health Professions to work with future elementary teachers. Arkansas has achieved substantial success in leveraging
administrative support to sustain other PhysTEC initiatives. For instance, the University decided to dedicate its Noyce Scholarship Program proposal to the PhysTEC faculty to allow them to fund tuition for pre-service teachers, and a Math and Science Partnership is helping extend some of the gains made in physics to the math program. Arkansas also participates in the PhysTEC Noyce project—two Arkansas students were in the first class of PhysTEC Noyce scholars, and three are in this year’s class.

University of Colorado at Boulder site leaders have developed a sophisticated Learning Assistant program that has become the model for many institutions around the country, thanks in part to a PhysTEC-sponsored workshop led by Colorado faculty in Fall of 2007. The Learning Assistant program allows students to experience the positive aspects of teaching, and serves as a recruitment tool into the teacher certification process, with around 15% of all Learning Assistants going on to complete a teacher preparation program. It is very popular, with over 50 students applying for approximately 18 spots in physics courses alone each semester. The teaching experience is augmented with a weekly course on teaching and learning physics, co-taught by an education faculty member and a former Teacher-in-Residence. Colorado has also gathered data to show that Learning Assistants score on par with first-year graduate students on commonly used content assessments. They can also demonstrate that their Learning Assistant program has improved undergraduate performance in physics courses, facilitated multi-disciplinary collaboration among faculty, involved more faculty in teacher preparation efforts, and recruited talented science majors to teaching careers. The Learning Assistant program has spread beyond Physics and Astronomy to all of the major STEM (Science, Technology, Education, and Mathematics) departments. The university’s PhysTEC efforts have been further augmented by a number of collaborative grant proposals, including NSF Noyce Teaching Fellowships and a recent UTeach replication award through the National Math and Science Initiative.

Western Michigan University focused its PhysTEC efforts on reforming its introductory physics course sequence, recruiting additional physics majors and minors, and preparing their teaching graduates to use interactive methods. As at many institutions, faculty adoption of course reforms has been uneven, which has allowed project leaders to gather data to show convincingly that interactive courses yield significantly higher gains on concept assessments than do traditionally taught courses. Western Michigan project leaders also report that they have “built a community of physics teachers composed of pre-service teachers, novice teachers, and

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experienced local teachers of physics. This community served as a support system for our graduates and other novice teachers as well as out-of-field teachers of physics.” To help support ongoing efforts in teacher education, Western Michigan decided to hire a tenure-track faculty member in physics education research. In addition, Western Michigan plans to focus on the fields of physics, chemistry, and math for its Woodrow Wilson Teaching Fellowship program. Western Michigan is a PhysTEC Noyce site, and has two scholars in the 2010-2011 cohort.

2.4 Future Funding Opportunities
The project anticipates providing funding for approximately six additional sites per year (three comprehensive, three pilot) for the next two years.

2.5 PhysTEC Endorsement
Project leaders have decided to offer “PhysTEC endorsement” to institutions that have not received PhysTEC funding, but whose physics teacher preparation programs meet the standards of the project. Institutions seeking endorsement will submit an application, and will partially fund a site visit by project leaders. Endorsed institutions will enjoy many of the same benefits as funded (present and past) sites, including the ability to offer PhysTEC Noyce scholarships to their students, being featured in conferences and workshops, and connection to a national network of PhysTEC sites.

3. Dissemination and Advocacy
The PhysTEC project views dissemination of project successes and advocacy for physics faculty involvement in teacher education as absolutely essential and central to its mission. The project pursues these goals through a wide variety of efforts in different media and venues.

3.1 The Physics Teacher Education Coalition
In addition to the funded PhysTEC Institutions, the project is also building a broad Coalition of institutions committed to improving physics and physical science teacher education. The goals of the Coalition are to

- Build a network of institutions engaged in reforming physics teacher education;
- Promote and disseminate successful programs, methods, and ideas; and
- Advocate nationally for improving science teacher education.

Since shortly after its inception in 2003, the Coalition has been known by the acronym PTEC. Earlier this year, project management decided that the dual acronyms PhysTEC and PTEC were causing confusion, and that PTEC would be phased out over the next year. The project has initiated efforts to combine the PhysTEC and PTEC websites, which will be the major challenge in retiring PTEC. Consequently, throughout this report and in future writings of the project we will refer to PhysTEC rather than PTEC to reflect the unified “branding” of project activities.

3.1.1 Coalition Membership
Coalition members are institutions that are involved in preparing pre-service physics teachers. Some of these institutions have well-developed programs that graduate multiple teachers per
year; others engage at a lower level but participate in conferences and workshops to get ideas from leaders in the field. Coalition membership is free, but the project requires that members identify one or more contact people, at least one of whom must be a physics faculty member; maintain a page on the project website; and provide the past three years’ worth of physics teacher graduate data upon joining, which they then update annually. Institutions that do not graduate physics teachers, such as national labs and two-year colleges, can join as “affiliate members.” As of this writing the Coalition has 185 member institutions, up from 139 in July 2009.

Coalition institutions do not receive direct funding, but the project sponsors an annual conference and several workshops dedicated to teacher preparation during the course of the year, and Coalition members are invited to participate at a reduced rate. The project strives to provide these institutions with appropriate expertise and information to advance their programs, and to mobilize them to act as a powerful force to convince the broader physics community of the importance of engaging in teacher education.

The graph at right shows growth in Coalition membership over the past six years. A complete list of Coalition members (as of this writing) can be found in Appendix C of this report.

3.1.2 Conferences and Workshops
PhysTEC conferences and workshops are the most important way the project disseminates successful programs and builds widespread support for physics teacher education reform. These events are important for both the formal sharing of programs and ideas through invited sessions and the relationships that are built through informal networking.

3.1.2.1 Annual PhysTEC Conference
Since 2005, the PTEC Conference (now referred to as the PhysTEC Conference) has been held annually in late winter, and has attracted many of the leaders in physics teacher preparation from around the country. The format includes two days of 1.5-hour workshops and panel discussions in three or four parallel tracks, lunchtime plenary speakers, and opening and closing sessions. The project works hard to ensure that all workshops provide opportunities for participant engagement, and that the conference schedule also includes ample time for attendees to interact with each other outside of programmed sessions. The above table shows conference locations and attendance. The site for the PhysTEC Conference is chosen specifically to engage a larger audience and reach out to a broad cross-section of the physics community.
The 2010 Conference was held in conjunction with the APS “April” Meeting and the AAPT Winter Meeting in Washington, DC on February 12 and 13, 2010. This was the sixth annual PhysTEC Conference, and for the fourth straight year it attracted 100 or more participants. Attendance was slightly down compared to past years due to extremely difficult travel conditions caused by inclement weather; however, over 80% of those pre-registered were able to attend some or all of the meeting. A pre-conference workshop on Funding for Teacher Education Programs had to be canceled due to inclement weather; however, several of the sessions planned for this event were rescheduled during the PhysTEC Conference as time and space allowed.

The theme of this year’s conference was “Diversity in Physics Education: Preparing Teachers for the 21st Century.” In two panel discussions on Friday participants heard the perspectives of young teachers in urban classrooms as well as faculty members at urban institutions. Another workshop tackled the challenges of rural physics education. Other conference sessions focused on the persistent achievement gap between richer and poorer students, as well as between underserved minority students and the rest of the US population. A panel of faculty and teachers discussed the preparation not just of teachers but of teacher leaders who will address such inequalities by becoming change agents in the educational system.

The conference also featured a number of national efforts in science and mathematics teacher preparation. Michael Marder, who co-directs the University of Texas’ UTeach Program, led a workshop on the UTeach replication effort, which supports thirteen universities to develop programs modeled after the one at Texas; Marder’s workshop was followed by one led by a UTeach Replication site leader. Other groups represented included the American Chemical Society, which led a workshop on the “Chemistry Teacher Education Coalition,” a PhysTEC-inspired effort to engage chemistry departments in teacher education; and the Association of Public and Land-grant Universities, which organized a reception for conference attendees whose institutions are members of the Science and Mathematics Teacher Imperative, a group of public research universities that have committed to increasing the number of science and math teachers they prepare.

More information and presentations from the conference are available at www.PTEC.org/conferences/2010

The 2011 PhysTEC Conference will be held in Austin, TX on May 23 and 24, 2011, with the theme of “Building Sustainable Programs.” The 2011 Conference will be held jointly with the UTeach Institute Annual Conference.

### Table 2. PhysTEC Conference Attendance

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
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</tr>
<tr>
<td>2009</td>
<td>Pittsburgh, PA</td>
<td>108</td>
</tr>
<tr>
<td>2008</td>
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<td>117</td>
</tr>
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<td>2007</td>
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<td>85</td>
</tr>
<tr>
<td>2005</td>
<td>Muncie, IN</td>
<td>82</td>
</tr>
</tbody>
</table>

3.1.2.2 Regional Conferences
The project holds regional meetings to catalyze change in states with large university systems, and in regions where the project has connections that it hopes to leverage into significant action on teacher preparation. The first of these was held in August 2007 at the University of North
Carolina-Chapel Hill, and brought together faculty from 14 of the 16 institutions in the UNC system. The second was held in October 2008 at Seattle Pacific University in Seattle, Washington, and was attended by around 30 teacher preparation professionals, and a similar number of Seattle-area K-12 teachers. For more information on these conferences, see www.PTEC.org/conferences

3.1.2.3 Topical Workshops
The project has held four topical workshops focusing on particular elements of teacher preparation. Most recently, on April 19 and 20, 2010, the project held a workshop at Rutgers University in New Brunswick, New Jersey to assist faculty in developing their future teachers’ pedagogical content knowledge (PCK), a concept described by Lee Shulman24 as the unique combination of content and pedagogical knowledge that is essential to the teaching profession. The workshop included knowledge of students’ difficulties and prior conceptions as well as content-specific productive representations, instructional strategies, and assessment methods. Participants met students and graduates of the Rutgers Ed.M. Certification Program in Physical Science and Physics Education who are New Jersey physics teachers. They also attended workshop meetings, mock classes, and actual classes in the program. See www.PTEC.org/conferences/pck2010 for more information.

Past topical workshops include

- A full-day workshop in partnership with the Association of Public and Land-grant Universities in March 2009, just before the 2009 PhysTEC Conference.
- A two-day workshop in October 2007 on the University of Colorado at Boulder’s Learning Assistant program. Twenty-two faculty members from 14 PhysTEC and Coalition institutions came to Boulder for this intensive workshop. With the growing number of Coalition institutions implementing Learning Assistants, the project has had preliminary discussions with CU-Boulder about the possibility of organizing a second workshop on this topic.
- A three-day workshop focusing on the Reformed Teaching Observation Protocol25, which took place at the American Center for Physics in College Park, Maryland in October 2006.

The project is also considering a workshop on assessing teacher effectiveness in the coming academic year. This workshop will be a gathering of invited experts in physics teacher education and physics education research, with the possible goal of producing a white paper on this subject, which is currently the focus of much study.

3.1.2.4 PhysTEC Programmatic Review Board
A group called the PTEC Steering Committee met occasionally to advise project management on directions for the Coalition. Earlier this year, project leaders decided to re-envision the Steering Committee as the PhysTEC Programmatic Review Board, which will consider a variety of

questions related to the project, but not limited to Coalition issues. The board will be comprised of recognized experts in physics teacher education who will provide intellectual guidance on project initiatives and programs. The board will meet two to three times per year, primarily by teleconference. See Appendix A.5 for Programmatic Review Board members.

3.2 Online dissemination
The PhysTEC project uses a number of online venues to publicize its activities and progress.

3.2.1 PhysTEC website
The PhysTEC website (www.PhysTEC.org) is organized around eleven “key components” that have been essential to the success of PhysTEC sites, and the website contains a page on each of these, with background information, strategies for implementation, and resources. PhysTEC institutions’ cumulative annual reports are also available, for readers who want more detail on a particular program. Also on the website are all PhysTEC annual and quarterly reports, presentations and publications from project participants, news and announcements, and information about project outcomes. Data from Google Analytics indicate that the PhysTEC website receives over 1,000 visits a month.

3.2.2 PTEC Website
The PTEC website (www.PTEC.org), which was redesigned in Fall 2009, hosts information about the Coalition, including a database of member profiles and web pages for PhysTEC conferences and workshops. In addition, the site contains a collection of resources devoted to physics and physical science teacher preparation that is part of ComPADRE, an NSF-funded digital library of resources for physics and astronomy education created by AAPT, AIP, APS, and the American Astronomical Society (AAS). The project is working with the collection editor, John Stewart (University of Arkansas), to highlight high-quality materials in the collection.

The combined PhysTEC-PTEC website (see above) will use the current PTEC design and wireframe, but will be hosted on APS servers.

3.2.3 Discussion list
The Coalition email discussion list includes representatives from all Coalition member institutions, and serves as a place where project leaders can inform members about events, policy developments, and funding opportunities related to teacher preparation. The AAPT Committee on Teacher Preparation list, though not managed directly by the project, has many Coalition representatives as members, and occasionally hosts lively conversations about physics teacher preparation topics. Other email lists, including ones for PhysTEC site leaders, TIRs, and PhysTEC teachers, serve mostly to help disseminate announcements for events.

3.3 National Task Force on Teacher Education in Physics
The joint AAPT/AIP/APS National Task Force on Teacher Education in Physics grew out of the PhysTEC project. Project leaders came to realize that an authoritative national report would greatly raise the profile of physics teacher education, and help disseminate the best practices in the field, as well as advocate for more resources. The Task Force released a document that includes a set of findings and recommendations on February 13, 2010 at the PhysTEC
Conference. The release, which summarizes more than two years of research on physics teacher preparation programs at US universities, is the synopsis of a report the task force plans to publish in Summer 2010 and distribute to every physics department and education school in the country. The report will also be disseminated through presentations, workshops, and other mechanisms, under the auspices of the sponsoring professional organizations. To date, Task Force members and project leaders have given six talks on the outcomes of the project, including a special topical session during the 2010 AAPT Winter Meeting.

The task force found that, “Except for a handful of isolated pockets of excellence, the national system of preparing physics teachers is largely inefficient, mostly incoherent, and massively unprepared to deal with the current and future needs of the nation’s students.” The authors identified a number of areas in which they felt improvement was needed, including collaboration between physics and education departments, physics-specific pedagogical preparation of teachers, induction and mentoring support for new physics teachers, and professional development for physics teachers coming from other disciplines.

The authors also drew a connection between the state of US physics teacher education and the country’s challenges in the science and engineering labor market, stating that “An effective precollege physics education is indispensable in preparing U.S. students for global competition.” To address these challenges, the authors wrote that “Physics departments, schools of education, university administrators, school systems, state agencies, the federal government, as well as business and foundations, have indispensable collaborative roles to play so that every high school student has the opportunity to learn physics with a qualified teacher.”

More information and a summary of the task force’s findings and recommendations are available at www.PTEC.org/TaskForce. See Appendix A.4 for a list of Task Force members.

3.4 Publications and Presentations
The PhysTEC project aims to disseminate its successes and findings in a wide variety of venues, targeting diverse audiences. For a full list of publications by project members, see Appendix B. For selected presentations on PhysTEC, please see www.PhysTEC.org/presentations.

3.4.1 Annual PhysTEC Newsletter
In Fall 2009 the project published the third edition of its newsletter PhysTEC News. The goal of this publication is to create a high-quality piece of publicity material to represent the project to sponsoring society board members, university administrators, faculty, donors, and potential project partners. The newsletter has been given to the APS and AAPT Executive Boards, and mailed to all Coalition and PhysTEC institutions as well as the chairs of every US physics department that grants a bachelor’s degree. The newsletter also serves as the top giveaway at the project’s exhibition booth. The next newsletter is planned for Fall 2010.

3.4.2 Book: Collected Papers on Teacher Preparation
The project is sponsoring a book of peer-reviewed papers on physics teacher preparation, to be published jointly by APS and AAPT. The book will include new reports on cutting-edge research and practice, as well as selected reprints of seminal papers. Printed copies will be distributed to chairs of all physics departments in the United States, and the book will also be freely available.
Publication in either of the peer-reviewed journals *Physical Review Special Topics-Physics Education Research* or the *American Journal of Physics* is a prerequisite for inclusion in the book, and all articles are going through the review and editing process at one of these journals. In addition to reprinting each of the articles, the book will include one-page synopses of each article. The project expects the book to be completed in early 2011.

### 3.4.3 Videos
Recognizing the importance of digital media, especially for the generation of students who are in college now, the project has devoted significant resources toward video production in the past two years. In February, the project released a five-minute video entitled “Teach Physics,” which is designed to inspire physics majors to pursue a career in teaching. The video features four young physics teachers who talk about what excites them about their jobs, as well as extensive footage from these teachers’ classrooms. The video was screened at the 2010 PhysTEC Conference, and all attendees received a DVD copy. In addition, the video is available online, along with code to embed the video in other websites. Previously, the project had made a video profile of a graduate of the Cal Poly teacher education program. Both videos can be seen at [www.PhysTEC.org/video](http://www.PhysTEC.org/video).

The project recently completed a two-minute video promoting the [Robert Noyce Teacher Scholarship Program](http://www.noyceprogram.org). The video is intended for potential scholarship applicants, and was screened at the 2010 NSF Noyce Conference. DVD copies of the video, along with a shortened version of “Teach Physics,” were made available to all conference participants. The video will be made available on the internet soon.

### 3.4.4 APS News
The project publishes articles periodically in *APS News*, APS’s monthly newspaper that goes out to its 48,000+ members. In June 2010, *APS News* ran an article on the five new sites, and in April 2010, it ran articles about the PhysTEC Conference and the Task Force. A bimonthly feature called the “Education Corner” also frequently features news about the project.

### 3.4.5 APS Forum on Education (FEd) Newsletter
Since 2005, the APS *Forum on Education Newsletter* has contained a section on teacher preparation. Every PhysTEC site has published at least one article in this newsletter, which is distributed electronically to over 4,000 APS members and freely available on the web. In the Spring 2010 edition Rob Thorne, PhysTEC site leader at Cornell, wrote about the program at his institution. In Fall 2009, John Stewart, the Teacher Preparation Section editor, wrote about the PTEC.org website and digital library collection, of which he is also the editor.

### 3.4.6 AAPT eNNOUNCER
PhysTEC-related announcements regularly appear in AAPT’s monthly email newsletter to members.

### 3.4.7 Status Reports
The project publishes status reports approximately every three months. These are sent to NSF Program Officers, partner society heads, and PhysTEC and Coalition members, and are placed on the PhysTEC website for the general public.
3.5 Presence at AAPT and APS Meetings
The project has been increasing its presence at AAPT and APS meetings, in order to reach out to a greater fraction of the physics faculty around the country. A booth for the project was unveiled for the first time in the exhibition hall at the 2007 AAPT Summer Meeting in Greensboro, NC, and has appeared at all AAPT and APS national meetings since then, evolving along the way. The project has also sponsored or co-sponsored a number of sessions at AAPT meetings, including a Symposium on Physics Education at the 2010 Winter Meeting at which the Task Force’s findings and recommendations were presented.

The project also organizes a one-day professional development workshop every year for PhysTEC teachers and TIRs, prior to the AAPT Summer Meeting. Funding is provided for TIRs just finishing or just beginning their terms, as well as PhysTEC graduates from the past three years who complete an application. Past workshops have included panel discussions of teachers and TIRs, discussion of assessment instruments such as the FCI and the Diagnoser, and sessions on interactive teaching methods and pedagogical content knowledge. This year’s workshop will feature the Modeling Instruction Program.

4. Collaborations
In order to maximize its impact, the PhysTEC project seeks collaborations with a wide range of partnering organizations and efforts. UTeach, a highly successful science and math teacher preparation program that began at the University of Texas in Austin, was strongly represented at the 2010 Conference, with two workshops devoted to the UTeach replication effort. The 2011 PhysTEC Conference is scheduled to be held jointly with the UTeach Institute’s annual conference.

The project has also engaged the American Chemical Society (ACS) to launch a parallel effort for chemistry teachers, and this year’s PhysTEC Conference featured a workshop on the “Chemistry Teacher Education Coalition,” which is a PhysTEC-inspired effort by the ACS to engage chemistry departments in teacher education. ACS has also issued a statement in support of chemistry departments engaging in teacher education, and has invited institutions to sign onto this statement, another initiative modeled after PhysTEC. In addition, the project continues to work with the Association of Public and Land-grant Universities, whose Science and Mathematics Teacher Imperative is engaging university administrations to take pledges to increase the number of science and math teachers prepared at their institutions.
APPENDIX A: Project Personnel

A.1 PhysTEC Management Team

A.1.1 Present Members

- **Theodore Hodapp**, PI (2004-2010), Director of Education and Diversity, APS. Hodapp is the primary contact for the NSF and is responsible for overall direction and fiscal management of the project. He coordinates the many components of the project and visits each funded institution at least once a year. He maintains on-going communication and timely reporting to NSF. He spends roughly 50% of his time on the PhysTEC project.

- **Warren Hein**, (2001-2010; co-PI 2005-2007, 2008-2009, 2010), Executive Officer, AAPT. Hein leads the project’s efforts to engage teachers and TIRs. He has also been responsible for AAPT’s PhysTEC activities, including collaborations with the Physics Teacher Resource Agent (PTRA) program, dissemination of PhysTEC activities through the AAPT journals, and PhysTEC sessions at AAPT meetings.

- **Monica Plisch**, (2007-2010; co-PI 2009-2010) Assistant Director, Education, APS. Plisch is responsible for project assessment and manages Coalition activities, including the annual PhysTEC Conference. She also directs the PhysTEC Noyce project. Plisch participates in site visits and works with Hodapp to manage other aspects of the project, and spends around 80% of her time on the PhysTEC project.

- **Jack Hehn**, co-PI (2001-2009), Director of Education Programs, American Institute of Physics. Hehn was a member of the original proposing team and continues to participate in the Project Management Team. He coordinated the initial activities of the External Evaluator (The Momentum Group, Inc.) in formative evaluation efforts. Hehn continues to advise the project.

- **Gabriel Popkin**, Project Manager (2007-2010), APS. Popkin manages many of the day-to-day operations of PhysTEC, including overseeing project communications, managing project and budgetary data, and drafting project documents and promotional materials.

- **Sara Webb**, Project Coordinator (2010), APS. Webb is taking on a number of the day-to-day operations of PhysTEC, including coordinating meetings, updating project websites, and handling a variety of other tasks.

- **Jon Anderson**, TIR and Mentoring Consultant (2009-2010). Anderson is responsible for coordinating TIR activities and outreach to PhysTEC teachers. He participates in Project Management Team meetings.

A.1.2 Past Members

- **Philip Hammer**, *co-PI* (2009-2010), Associate Executive Officer, AAPT. Hammer led the project’s efforts to engage teachers and TIRs and coordinated efforts of AAPT for the project.

- **John Layman**, *co-PI* (2001-2005), Professor Emeritus at the University of Maryland. Layman participated in site visits. He led the effort and program to establish the TIR group, and helped in organizing two of the first annual project meetings. Layman spearheaded the formal Induction/Mentoring program within PhysTEC and collaborated with AAPT’s PTRA program to create the summer TIR/PTRA Induction and Mentoring workshop.

- **Fredrick Stein**, *PI* (2001-2004), former Director of Education and Outreach, APS. Stein served as PI until his retirement from the APS in September 2004. He worked 50-60% time on the PhysTEC project.

- **Charlie Holbrow**, *co-PI* (2008), Executive Officer, AAPT. Holbrow replaced former AAPT Executive Officer and co-PI Toufic Hakim.

- **Toufic Hakim**, *co-PI* (2007-2008), Executive Officer, AAPT. Hakim replaced Warren Hein as co-PI during Hein’s rotation at the NSF.

- **Mary Fehrs**, Associate Project Director for Coalition Development, APS (2005-2007). Fehrs was responsible for organizing and managing the annual PhysTEC conference, inviting speakers, writing and disseminating the publicity materials, and developing meeting structure. She recruited and communicated with potential Coalition members and was responsible for the ongoing development of the Coalition.

- **Edward Lee**, Project Associate, APS (2001-2010). Lee’s responsibilities included participating in Project Management Team meetings and editing project documents.

- **Victoria Kwasiborski**, Project Manager (2005-2007), APS.

- **John Gretz**, Project Coordinator (2004-2005), APS.

- **Kevin Aylesworth**, Project Coordinator (2002-2004), APS.

- **Shirley Wilson**, Project Assistant, APS (2009-2010). Wilson assisted the project with a range of administrative activities.

A.2 Past Management Team Consultants

- **Paul Hickman**, TIR and Mentoring Consultant (2005-2009). Hickman was responsible for coordinating TIR activities, and participated in Project Management Team meetings.
• **Drew Isola**, Consultant (2008-2009). Isola, a former Teacher-in-Residence, has been responsible for a variety of activities related to TIRs and PhysTEC teachers.

• **Marcia Fetters**, TIR Consultant (2005)


• **Gay Stewart**, Outreach Consultant (2005)

### A.3 Advisory Committee

#### A.3.1 Current Advisory Committee

The new Advisory Committee will meet for the first time in Fall 2010. Members are:

• **Helen Quinn**, Chair, Professor Emeritus, Stanford Linear Accelerator Center

• **Keith Clay**, Professor, Physics Department, Green River Community College

• **Mary Kirchhoff**, Director, Education Division, American Chemical Society

• **Jill Marshall**, Associate Professor, Department of Education, University of Texas at Austin

• **Jose Mestre**, Professor, Department of Physics, University of Illinois at Urbana-Champaign

• **Kimberly Mitchell**, Senior Program Officer, Bill and Melinda Gates Foundation

• **JoAnne Vasquez**, Vice President, Helios Foundation

#### A.3.2 Original Advisory Committee

The original Advisory Committee last met in May 2007. Members were:

• **George H. Trilling**, Chair, Professor Emeritus, University of California, Berkeley, (Term: 2001-2007)

• **Robert Beck Clark**, Professor, Department of Physics and Astronomy, Brigham Young University (Term: 2001-2007)

• **Sandra Harpole**, Director, Center for Science, Mathematics, and Technology, Mississippi State University (Term: 2001-2007)

• **Paul Hickman**, Director of CESAME, Northeastern University (Term: 2001- 2005)

• **E. Leonard Jossem**, Professor Emeritus, Department of Physics, The Ohio State University (Term: 2001-2007)

• **Jill Marshall**, Associate Professor, Department of Education, University of Texas at Austin (Term: 2005-2007)

• **Lillian McDermott**, Professor, Department of Physics, University of Washington (Term: 2001-2007)

### A.4 Task Force Members

• **Stamatis Vokos**, Chair (Seattle Pacific University)

• **Eugenia Etkina** (Rutgers University)

• **J. D. Garcia** (University of Arizona)

• **David Haase** (North Carolina State University)

• **Drew Isola** (Allegan Public Schools)
• Eugene Levy (Rice University)
• Valerie Otero (University of Colorado at Boulder)
• Mary Ann Rankin (University of Texas at Austin)

Society Liaisons:
• Jack Hehn (American Institute of Physics)
• Warren Hein (American Association of Physics Teachers)
• Theodore Hodapp (American Physical Society)
• Cathy O'Riordan (American Institute of Physics)
• Monica Plisch (American Physical Society)

Senior Consultant: David Meltzer (Arizona State University)

A.5 Programmatic Review Board Members
• Eugenia Etkina (Rutgers University)
• Noah Finkelstein (University of Colorado at Boulder)
• Michael Marder (University of Texas at Austin)
• Gay Stewart (University of Arkansas)
• Stamatis Vokos (Seattle Pacific University)

Former member:
• Paula Heron (University of Washington)
## APPENDIX B: PhysTEC Publications

### B.1 Project Management Team (PMT) Publications

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary Author</th>
<th>Title</th>
<th>Location/Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Popkin</td>
<td><strong>PhysTEC Scholarship Program for Future Physics Teachers</strong></td>
<td>APS Forum on Education Newsletter, Summer 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td><strong>Teacher Education Program Adds Five New Sites</strong></td>
<td>APS News, April 2010</td>
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<tr>
<td>2010</td>
<td>Popkin</td>
<td><strong>Teacher Preparation Conference Focuses on Diversity</strong></td>
<td>APS News, April 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td><strong>Task Force Calls Physics Teacher Preparation Massively Inadequate</strong></td>
<td>APS News, April 2010</td>
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<tr>
<td>2009</td>
<td>Popkin (editor)</td>
<td><strong>PhysTEC News</strong></td>
<td>PhysTEC News, Fall 2009</td>
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<td>2009</td>
<td>Popkin</td>
<td><strong>APS-Led Project Receives $6.5M NSF Grant</strong></td>
<td>APS News, October 2009</td>
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<tr>
<td>2009</td>
<td>Hodapp, Hehn, Hein</td>
<td><strong>Preparing High School Physics Teachers</strong></td>
<td>Physics Today, February 2009</td>
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<tr>
<td>2008</td>
<td>Popkin</td>
<td><strong>Novice Scholarships to Aid Selected Physics Teachers</strong></td>
<td>APS News, November 2008</td>
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<td>2008</td>
<td>Popkin (editor)</td>
<td><strong>PhysTEC News</strong></td>
<td>PhysTEC News, Fall 2008</td>
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<td>2008</td>
<td>Popkin</td>
<td><strong>Towson PhysTEC Project Targets Elementary Science Teaching</strong></td>
<td>Capitol Hill Quarterly, September 2008</td>
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<td>2008</td>
<td>Popkin</td>
<td><strong>Conference Connects Physics Teacher Educators</strong></td>
<td>APS News, April 2008</td>
</tr>
<tr>
<td>2008</td>
<td>Popkin (editor)</td>
<td><strong>PhysTEC News</strong></td>
<td>PhysTEC News, Spring 2008</td>
</tr>
<tr>
<td>2008</td>
<td>Popkin</td>
<td><strong>Learning Assistants Impact Undergraduate Teaching</strong></td>
<td>APS News, February 2008</td>
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<td>2007</td>
<td>APS Staff</td>
<td><strong>Four New Sites Added to Teacher Education Program</strong></td>
<td>APS News, April 2007</td>
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<td>2006</td>
<td>APS Staff</td>
<td><strong>Featured PhysTEC University: University of Colorado</strong></td>
<td>APS News, March 2006</td>
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<td>2005</td>
<td>APS Staff</td>
<td><strong>Featured PhysTEC University: Arkansas Ramps Up Teacher Preparation</strong></td>
<td>APS News, December 2005</td>
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<td>2005</td>
<td>APS Staff</td>
<td><strong>Featured PhysTEC School: University of Arizona</strong></td>
<td>APS News, May 2005</td>
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<td>Institution</td>
<td>Year</td>
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<td>Institution</td>
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<tr>
<td>Minnesota</td>
<td>2008</td>
<td>Anderson, J.</td>
<td>The first Year of PhysTEC at the University of Minnesota</td>
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<td>Location</td>
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<td>Authors</td>
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<td>Renwick, E.</td>
<td>and lessons learned</td>
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<td>Michigan</td>
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<td>Michigan</td>
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<td></td>
<td>University</td>
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<tr>
<td>Arkansas</td>
<td>2006</td>
<td>Stewart, G.</td>
<td>Recruiting New Teachers At The University Of Arkansas</td>
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<td>Arkansas</td>
<td>2006</td>
<td>Stewart, G.</td>
<td>Undergraduate Learning Assistants At The University Of Arkansas</td>
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<td></td>
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<td>learning physics: the Colorado Learning Attitudes about Science</td>
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<td>Survey</td>
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<td>a fine-grained characterization</td>
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<td>Colorado</td>
<td>2006</td>
<td>Otero, V.</td>
<td>The Learning Assistant Model for Teacher Education in Science and</td>
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<td>the impact of multiple instructors in large lecture classes</td>
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<td>Pacific</td>
<td></td>
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<td>Community at Seattle Pacific University</td>
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<tr>
<td></td>
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<td>Tirrochi, L.</td>
<td>improve an elementary science practicum</td>
</tr>
<tr>
<td>Arizona 2004</td>
<td>Novodvorsky, I.</td>
<td>Teaching as they were taught: The importance of reformed university courses, Quality Development in Teacher Education and Training</td>
<td>Proceedings of 2nd International GIREP Seminar, Udine, Italy, 2004.</td>
</tr>
</tbody>
</table>

Members of the project have given numerous presentations to local, regional, and national audiences. Selected presentations by PhysTEC project leaders are available at: www.PhysTEC.org/presentations.

**B.3 PhysTEC Press**

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<thead>
<tr>
<th>Title</th>
<th>Publication</th>
<th>Date</th>
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<tr>
<td>Cornell producing future high school physics teachers</td>
<td>Cornell University Chronicle</td>
<td>11/30/2009</td>
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<tr>
<td>FIU's New Approach to Teaching Sends Scientists into the Classroom</td>
<td>News@FIU</td>
<td>11/30/2009</td>
</tr>
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<td>A genuine teaching experience</td>
<td>Physics Today</td>
<td>October 2009</td>
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<tr>
<td>PhysTEC Integrates Physics, Education</td>
<td>NSTA Reports</td>
<td>January 2009</td>
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<tr>
<td>U takes part in effort to improve physics teaching</td>
<td>Minnesota Daily</td>
<td>11/9/2008</td>
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<td>Teaching Physics Matters</td>
<td>Connect</td>
<td>Fall 2008</td>
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APPENDIX C: PTEC Membership as of July 9, 2010

Anderson University
Andrews University
Angelo State University
Arizona State University
Auburn University
Ball State University
Bemidji State University
Boise State University
Boston University
Bridgewater State College
Brigham Young University
Brigham Young University-Idaho
Buffalo State University
California Polytechnic State University, Pomona
California Polytechnic State University, San Luis Obispo
California State University, Chico
California State University, Fresno
California State University, Long Beach
California State University, Sacramento
California University of Pennsylvania
Calvin College
Casper College
Chatham University
Chicago State University
Chuvash State Teacher Training University
Claflin University
Colgate University
Cornell University
DePaul University
Dodge City Community College
East Central University
Eastern Illinois University
Elon University
Emporia State University
Fairmont State University
Florida A & M University
Florida International University
Florida State University
Fort Hays State University
Francis Marion University
George Washington University
Georgia Southern University
George Washington University
Georgia State University
Hamline University
Hillsdale College
Hiram College
Hofstra University
Hope College
Illinois State University
Indiana University of Pennsylvania
Iowa State University
Ithaca College
Jackson State University
Jacksonville State University
James Madison University
Johns Hopkins University
Johnson C. Smith University
Juniata College
Kansas State University
Kennesaw State University
King College
Lehman College, City University of New York
Lincoln University
Lone Star College-North Harris
Louisiana State University
Loyola College in Maryland
McNeese State University
Medaille College
Michigan State University
Middle Tennessee State University
Millersville University
Misericordia University
Missouri University of Science and Technology
Monmouth College
Morningside College
National Superconducting Cyclotron Laboratory
North Carolina A&T State University
North Carolina State University
North Georgia College and State University
Northwestern Oklahoma State University
Oklahoma State University
Oranim Academic College
Oregon State University
Pacific University
Passaic County Community College
Pennsylvania State University
Pittsburg State University
Portland State University
Radford University
Randolph College
Rensselaer Polytechnic Institute
Rutgers, the State University of New Jersey
Saint Anselm College
Saint Joseph's University
Saint Mary's College
San Antonio College
San Jacinto College Central
Seattle Pacific University
Slippery Rock University
Sonoma State University
South Dakota State University
Southern Illinois University Edwardsville
Southern Oregon University
Spelman College
SUNY Cortland
SUNY Fredonia
SUNY Geneseo
Tennessee Technological University
Texas A&M University
Texas A&M University-Commerce
Texas Southern University
Texas State University-San Marcos
The Citadel
Towson University
Trinity Christian College
Tufts University
University of Alabama
University of Alabama at Birmingham
University of Arizona
University of Arkansas
University of California, Davis
University of California, Santa Cruz
University of Cincinnati
University of Colorado at Boulder
University of Connecticut
University of Education
University of Hawaii at Hilo
University of Houston
University of Idaho
University of Illinois
University of Illinois-Chicago
University of Kentucky
University of Louisville
University of Maine
University of Maryland, Baltimore County
University of Maryland, College Park
University of Massachusetts-Boston
University of Memphis
University of Michigan, Dearborn
University of Minnesota
University of Missouri
University of Missouri-Kansas City
University of Montana
University of Nebraska-Lincoln
University of Nevada, Las Vegas
University of Nevada, Reno
University of New Hampshire
University of North Carolina at Asheville
University of North Carolina at Chapel Hill
University of Northern Colorado
University of Northern Iowa
University of Notre Dame
University of Oregon
University of Pittsburgh
University of Pittsburgh at Greensburg
University of Rhode Island
University of San Diego
University of South Dakota
University of Southern Indiana
University of Southern Mississippi
University of Tennessee
University of Texas at Austin
University of Texas at El Paso
University of Texas at San Antonio
University of Texas at Tyler
University of Washington
University of Wisconsin-Madison
University of Wisconsin-River Falls
University of Wisconsin-Stevens Point
University of Wisconsin-Whitewater
University of Wyoming
Vincennes University
Virginia Tech
Weizmann Institute of Science
West Virginia State University
West Virginia University
Western Kentucky University
Western Michigan University
Wheeling Jesuit University
Winona State University
Winston-Salem State University
Women's Christian College
Worcester Polytechnic Institute
Wright State University
Xavier University of Louisiana