Executive Summary
This report documents the activities of the Physics Teacher Education Coalition (PhysTEC) project in the fourth year of its second round of funding (August 1, 2012 to July 31, 2013). The mission of PhysTEC is to improve and promote the education of future physics and physical science teachers. Specifically, the project aims to

- Transform physics departments to engage in preparing physics teachers
- Demonstrate successful models for increasing the number of highly qualified teachers of physics prepared at colleges and universities
- Spread best-practice ideas throughout the physics teacher preparation community

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 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 funds selected universities to develop their physics teacher preparation programs into national models with substantial project support. Four newly selected sites will begin funding in Fall 2013, bringing the total number of supported sites to 30. Supported sites 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 PhysTEC Member Institutions, which as of this writing number 283. The project organizes an annual national conference as well as smaller regional and topical workshops for these members.

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 published a book of collected papers on teacher preparation, *Teacher Preparation in Physics: Research, Curriculum, and Practice*, and in December 2012 it published a second major research and dissemination effort: the report of the national Task Force on Teacher Education in Physics. Project leaders are also seeking to magnify the project’s impact through collaborations with other organizations, including an effort by the American Chemical Society to launch the Chemistry Teacher Education Coalition.
1. Results

The PhysTEC project can report significant findings and results. The number of teachers graduating each year from PhysTEC institutions has greatly increased since the project began in 2001. The graph below contains the integral graph of total graduates from all PhysTEC sites each year since the initiation of the project. Of those graduates for whom the project has current employment information, over two thirds are teaching in a K-12 school. 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.

![Annual graduates from PhysTEC supported sites](image)

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: fewer than half of the 27,000 high school physics teachers in the U.S. have completed a major or minor in physics or physics education.1 The severe shortage of qualified high school physics teachers is confirmed by superintendents and principals, who rate physics teachers as the hardest to recruit.2 The shortage of physics teachers is becoming more critical, as the percentage of students taking physics in high school is increasing by approximately 1% per

---

In addition, many states have adopted laws requiring students to take 3-4 years of science (Texas now requires 4 years of science including physics). Legislation of this type, while addressing the need for a technologically literate workforce and citizenry, raises the question of who will teach these students physics. The consequences of the shortage of secondary physics teachers showed up strongly in the results of the latest Trends in International Mathematics and Science Study (TIMSS) where the U.S. participated in the advanced studies: U.S. high school graduates were ranked lowest in physics among all other countries surveyed.

1.1 Secondary Teacher Graduation Rates
PhysTEC sites committed to increasing the number of graduating physics teachers have been successful in meeting that goal. The graph below shows that PhysTEC legacy sites (no longer funded) have collectively more than doubled the number of physics teachers they graduate, and in some cases the increase has been a factor of 10 or more. By comparison, the increase in physics certifications per institution over a similar time period was negligible. While absolute numbers are not large, they indicate the impact PhysTEC reforms have when implemented. Each year, U.S. schools hire about 1400 new physics teachers, and only about 500 of these have a physics or physics education degree. By contrast, every PhysTEC teacher is required to have a physics major, a physics minor, or equivalent content preparation, and must have completed a teacher preparation program. If a significant fraction of the approximately 760 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.

Note that legacy sites are those institutions for which we believe the numbers of graduates reflect the full effect of project reforms. Because many project components impact students in their freshman and sophomore years, their effects cannot be seen in the graduation data until as many as four years later, when these students graduate from bachelor’s or Masters of Arts in Teaching (MAT) programs. Thus, among legacy sites, we see graduate numbers in years 4-6 that exceed those in years 1-3.

For all legacy sites, graduation rates of physics teachers have been sustained at an elevated level compared to pre-funding years. The project will continue to monitor graduation rates over time to look at the long-term sustainability of PhysTEC sites, and is currently engaged in a formal sustainability study to document this aspect of the project (see section 1.2.10.4).

---

3 S. White and C. Tesfaye, op cit.
4 Texas House Bill 1, 79th Legislature, 3rd Called Session, 2006.
6 Ball State University focused its project on improving middle school teacher education and building mentoring programs. Towson University focused its first project exclusively on elementary teacher education.
The project can now report data for more recently funded sites. Among these sites, we see growth in the numbers of graduates at all but one institution, and we expect to see continued growth as programs mature and reach their full impact. Note that PhysTEC sites focus mostly on recruiting undergraduates at their own institution; however, some institutions also educate substantial numbers of physics teachers who received their bachelor’s degree elsewhere. To more clearly see the impact of PhysTEC recruiting efforts, graduates have been separated according to certification pathway in the graph below.
Florida International University and University of North Carolina at Chapel Hill graduated their first physics teachers in recent memory under the PhysTEC project. The drop in teachers graduating from Cornell reflects a set of circumstances largely outside the control of project leaders, as amid budget cuts the education department was dissolved and there was uncertainty about the future of the certification program, which was later discontinued. Cornell does report an increase in undergraduates intending to become physics teachers, although a number of these students choose to get their certification elsewhere and cannot be counted in the numbers of graduates on the above graph.

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. In 2012, the project sent out a new web-based survey to all program graduates for whom it had up-to-date contact information. The goal of the web survey is to streamline collection of early career and teacher retention data from PhysTEC graduates. The survey will be sent to all graduates via email on an annual basis. Site leaders were asked to encourage graduates to complete the survey, and the survey completers received a complimentary gift from the project.
Of the 273 PhysTEC graduates, a survey link was sent to the 222 PhysTEC graduates for whom we had an email address. Of these, 96 responded to the survey for a response rate of 43%. The respondents were 76% white, non Hispanic, 6% white, Hispanic, 5% Asian, 3% Black, 3% Other, 2% Other-Hispanic, 2% Native American, and 2% did not provide their demographic information. As shown in the graph to the above, 86% of graduates became a teacher after completing the program and 3% are not teaching but intend to teach. The graph above illustrates that nearly all (91%) of those in K-12 schools are teaching physics and/or physical science. Other commonly taught subjects include math and chemistry. The three-year retention rate calculated from the survey data of PhysTEC teachers is 76%; the national average reported by the U.S. Department of Education for the academic year 2007-2008 for full and part time teachers is 74%.

1.2 Key Components

Successful physics teacher preparation programs share certain key components, and exist within a supportive institutional context. These contextual and programmatic components build on one another to provide teachers with a complete educational experience, from recruitment through early teaching experiences, 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.

1.2.1 Recruitment

A strong recruiting effort at most PhysTEC sites begins on the first day of classes, with faculty members, Teachers-in-Residence, and future teachers visiting introductory courses to introduce themselves and encourage students to consider teaching. This has the effect of legitimizing teaching as a career option in the eyes of students. Some sites distribute and collect information cards to target students who may be interested in considering a teaching career. A number of sites have also created posters, brochures, and other recruitment materials and put them up around science buildings and other areas that students frequent. Several sites have held open houses for high school students and teachers at which they promoted their teacher preparation program.

Introductory physics courses themselves also serve as important recruiting tools, provided the instructors model interactive, engaging teaching methods. Most PhysTEC sites have added undergraduate peer instructors called Learning Assistants. These programs can engage students who had expressed no previous interest in teaching, and encourage them to consider a teaching

---

Effective teacher recruitment also depends on creating a program that encourages and supports future teachers throughout their education. Some sites have created a degree program that provides undergraduates a physics major and teaching certification in four years; others have created alternative degree and certification plans that allow students flexibility in completing their education. Good advising and mentoring throughout the program is crucial to retaining interested students. Scholarship support can also be critical. 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.

The graph below shows the impact of project recruitment activities on the number of future teachers at sites that began funding in 2010 and 2011.

Almost all of the institutions show increases in the number of future physics teachers enrolled during PhysTEC funding. The increase is especially dramatic for MTSU, which at last count had 15 future physics teachers compared to none in 2008. Future teacher increases are expected in response to continually increasing recruiting efforts at Boston University and Chicago State. Overall, we expect these increases in future teachers will translate to increases in physics education graduates over the next few years.

In previous years, site leaders at several sites hired a marketing professional to help them develop targeted campaigns to recruit more physics majors and teachers. North Carolina formed a recruiting committee to implement many of the recommendations from their report. This includes a new recruitment strategy aimed at local high school physics students with the theme
“Do Physics. Be Anything.” Other institutions have also developed marketing campaigns and have been successful recruiting students to be future physics 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, and are promoted at meetings.

1.2.2 Early Teaching Experiences
PhysTEC views early teaching experiences as an important step along the teacher preparation continuum that begins with recruitment and extends into the first years of a teacher’s career. A well-designed early teaching experience can give freshmen or sophomores a low-pressure taste of the rewards and challenges of teaching. Project sites have offered a variety of early teaching experiences. Some have created programs that place pre-service teachers into local public school classrooms early on; some of these are modeled after Step 1, the course that kicks off the UTeach Program’s teacher preparation curriculum. Other sites have created in-house early teaching experiences in the form of Learning Assistant programs, which allow students to help educate their peers in undergraduate physics courses.

1.2.3 Pedagogical Content Knowledge
Pedagogical content knowledge (PCK) is subject-specific knowledge about teaching that includes student difficulties and prior conceptions, as well as content-specific instructional and assessment strategies. PCK has come to be recognized as a crucial element of what teachers need to be effective in the classroom. As the project moves forward, it is placing greater emphasis on having funded sites include PCK training in courses that their future teachers take. Sites with enough students in the program can offer a specialized course in PCK for physics teachers. Several of the currently supported sites have created specialized courses for future physics teachers.

One program that is exemplary in emphasizing PCK is Rutgers University’s teacher preparation program. On the strength of this program, Rutgers has become PhysTEC’s first endorsed site (follow link or see below for more detail). In Spring 2010, PhysTEC organized a topical workshop on PCK at Rutgers for Coalition members.

1.2.4 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. By engaging students who had expressed no previous interest in teaching, 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 the learning gains of students in classes that use them.9

---

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 as Learning Assistants.

All currently funded and most legacy sites have active Learning Assistant programs, and the idea is spreading beyond the PhysTEC community. In October 2012, the project sponsored its fourth two-day topical workshop on the Learning Assistant program at the University of Colorado at Boulder for faculty from Coalition and other institutions. A large fraction of the applicants to last fall’s request for proposals included Learning Assistant programs in their applications, and we have heard from a number of other participants that they have independently initiated Learning Assistants at their campus following participation in the workshops.

1.2.5 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. Most PhysTEC teachers in their first and second year of teaching are mentored by TIRs. In addition, PhysTEC TIRs provide 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 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.”

1.2.6 Champion
The champion is a change agent at the university who ensures program success. Typically, though not always, this is a tenured physics faculty member; the project has found that non-tenure track faculty members, lecturers, and emeritus faculty rarely have the clout necessary to effect change within a physics department. In addition, most physics departments do not have tenure and promotion structures that reward teacher preparation activities, so an untenured

---

professor puts him- or herself at risk by devoting too much time to activities that do not count toward promotion.

In some cases, the champion may actively run the program; in other cases, the champion may take a less active role, but he or she advocates for the program and steps up when support is needed. A successful champion is usually part of a leadership team. The project has found that the most successful leadership teams include someone with physics education research expertise, and someone who is knowledgeable about the local school context. Education faculty members or Teachers-in-Residence may be best equipped to provide this expertise.

1.2.7 Teachers-in-Residence

Over the course of the entire PhysTEC project, 53 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 also strengthen ties between theory and practice by sharing their expertise and classroom experiences with pre-service teachers. After their service in the project, more than half of the PhysTEC 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, which received a lower level of funding than some other Supported Sites, 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 providing funding for VMTs at PhysTEC Noyce sites to provide mentoring and support for Noyce scholars. The VMT may be an especially important model for smaller institutions.

A TIR takes on many roles, depending on the needs of the institution. 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;
• Creating and leading Teacher Advisory Groups with local teachers;
• Providing professional development workshops and courses on inquiry-based teaching;
• Acting as a spokesperson for the project and the institution in a variety of local and national settings;
• 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 surveyed all TIRs and site leaders to learn more about TIR roles. This information as well as other data will be published in the Effective Practices in Physics Teacher Education book due in early 2015.

1.2.8 Collaboration

Collaboration between physics departments, education schools, and local school districts is essential to create a coherent and effective teacher preparation program. 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, 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. Middle Tennessee State, Towson, and Arkansas are also UTeach replication sites.

1.2.9 Institutional Commitment

Institutional commitment means internal financial support to sustain program elements, and intellectual and cultural support for those who choose to go into teaching. Physics teacher education programs need support from physics and education faculty, chairs, and deans, as well as upper-level university administration.

PhysTEC has found that, for physics teacher education reform, the critical unit within a university or college is the physics department. Successful departments must recognize teacher preparation as part of their mission, and back this up by rewarding faculty for teacher preparation activities, encouraging and supporting students to pursue teaching careers, supporting course reform efforts, and if possible, hiring faculty with education experience and interest. Education schools also have a key role to play, in collaborating with physics departments to make sure their programs meet the needs of future physics teachers. Support from the upper administration is also crucial. Many universities are recognizing that they have a critical role to play in addressing the need for more highly qualified science and math teachers, and have implemented institution-wide or even system-wide initiatives to prepare more of these teachers. PhysTEC has been working closely with the Association of Public and Land-grant Universities (APLU) to engage university administrators in this effort.

1.2.10 Assessment

PhysTEC leaders recognize the need to gather data, both to determine whether the project 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 by gathering and analyzing data on

- The degrees, career outcomes, and retention rates of teachers who graduate from funded institutions (see section 1.1.2);
- 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 (see section 1.2.10.2); and
- The extent to which the project has catalyzed institutional transformation leading to sustainable teacher preparation programs (see section 1.2.10.4).

In addition to project-wide summative assessment, PhysTEC recognizes the importance of formative assessment, both as it relates to a teacher’s education and to the project as a whole. A number of 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 addition, the project has contracted with a consultant, Rachel Scherr, who is conducting project-wide formative assessment, with a final report due in late 2013.

1.2.10.1 Degrees, 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. In 2010, 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. Also as mentioned above, the project developed a new web survey tool to improve data collection on career outcomes and retention from PhysTEC graduates. We have shown the preliminary data above and expect to report final results after completing efforts to increase the response rate.

1.2.10.2 Content Assessment
The PhysTEC project encourages funded institutions to teach introductory physics courses that use interactive, research-based methods shown to improve student learning. These courses also serve to model effective teaching practices, and often involve more advanced students as Learning Assistants. PhysTEC has encouraged its sites to adopt proven curricular reforms because 1) PhysTEC understands that teachers teach as they have been taught and 2) these reforms have been shown to improve learning gains on standardized, research-based content assessments of conceptual understanding.11

PhysTEC sites use research-validated instruments including the Force Concept Inventory (FCI)12 and Conceptual Survey of Electricity and Magnetism (CSEM)13 to assess student learning at

---

PhysTEC sites and ensure that course reforms are effective. Typically, the normalized learning gain is used to assess the effectiveness of these courses; this is calculated by dividing the difference between post- and pre-test score by the difference between 100% and the pre-test score. The graph below shows learning gains for introductory physics courses taken by majors, some of whom will become physics teachers. Learning gains at many PhysTEC sites are in the range that is consistent with typical gains for courses using “interactive engagement” instruction, according to the literature\(^\text{14}\). Some sites’ gains are somewhat lower, reflecting inconsistent understanding and implementation of course reforms among faculty. We are working with these sites to improve undergraduate instruction; the concept exams are a tool to raise awareness among faculty about the effectiveness of instructional practices.

![Learning Gains for Introductory Physics Courses for Majors](image)

\(^\text{* Pre and post scores were unable to be matched.}\)

1.2.10.3 Teacher Assessment

The project encourages PhysTEC sites to conduct teacher observations for student teachers and recent PhysTEC graduates in the field. Existing observation protocols can be useful for providing feedback to new teachers and facilitating mentoring interactions. Funding was being provided for PhysTEC site leaders from currently funded sites to attend the UTeach Observation Protocol (UTOP) workshop at the 2012 AAPT Summer Meeting. The UTOP is an instrument to observe the classroom practices of teachers and is based on the Reformed Teaching Observation Protocol (RTOP) and the Inside the Classroom instruments of Horizon Research. The workshop provided training on how to use the UTOP to assess pedagogical practices shown by research to improve student learning.

The project has also attempted to measure the learning gains of high school students taught by PhysTEC teachers using the FCI. In each project year in the time period 2008-2012, about ten PhysTEC teachers administered the test to their students. Along with FCI pre-test and post-test scores, the project collected information from teachers on the school and classroom context in

\(^\text{14} \text{R. R. Hake, op cit.}\)
which they were teaching, both through surveys and telephone interviews. Analysis of data showed that for most teachers, average gains remained relatively consistent from year to year, and students in more advanced courses tended to have higher gains. Due to the limited data collected and the large number of variables that can affect student learning gains, drawing conclusions from this effort has been extremely difficult. The project has decided to put this effort on hold until there are more resources available for a dedicated research effort.

1.2.10.4 Sustainability
While PhysTEC sites have achieved impressive successes, project reforms 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 sites 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.

To better answer the question of how to catalyze systemic change, PhysTEC is conducting a study on the sustainability of change at legacy sites. The study seeks to answer (1) to what degree and (2) by what mechanisms physics teacher education has been sustained at legacy PhysTEC sites. The study is being conducted by phone interviews, site visits, and the collection of quantitative data. Eight legacy sites were selected for the study (excluding sites where elementary and/or middle school teacher education were the primary focus, funding was suspended, or personnel are unavailable for the study). All site visits and phone interviews have been completed and quantitative data for each site has been collected. Five institutions were investigated through comprehensive site visits and three through phone interviews. For each site:

- Quantitative data documents specific outcomes including the number of PhysTEC secondary graduates each year, the number of LAs each year, the faculty and staff who dedicate time to teacher education, and the funding for teacher education;
- A site summary survey summarizes briefly whether each of the PhysTEC key components has been maintained, grown, productively evolved, reduced, or eliminated since the period of PhysTEC funding; and
- A narrative report synthesizes the data into the history and future of the site in terms of personnel, funding, and programmatic and institutional changes relevant to physics teacher education.

By Fall 2013, site reports will be synthesized into a report for the PhysTEC Advisory Committee and at least one publication will be submitted to the American Journal of Physics (working title: "Sustaining Physics Teacher Education Programs," R. E. Scherr, M. Plisch, and T. Hodapp).

The primary audience for the report includes physics faculty, physics chairs, and other university administrators seeking to implement and sustain elements of the PhysTEC program. The report is also intended for professional societies that are actively engaged or seeking to support teacher education, including APS, AAPT, ACS, and APLU. Another possible audience is the NSF and
other current and potential funders, who can use the report to learn about the success of the PhysTEC model with regard to sustainability.

1.2.10.5 Formative Assessment
The better evaluate the project and how it can best serve the needs of the funded sites, an independent consultant led focus groups for both comprehensive and targeted site leaders at the March 2013 Leadership Council meeting. In the focus groups, the site leaders evaluated the project without the program management present. A report was drafted containing appreciation for specific aspects of the project and suggestions for improvement. Many sites commented how much they appreciate site visits and the recognition the project brings to the department within the university. Many site leaders have requested professional development and guidance on how to better collaborate with colleagues in education. The final report will be submitted to project management in late 2013.

1.2.10.6 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 meet annually for two days to learn about the project and provide guidance to project management on ongoing activities and future directions. The advisory committee met for the second time in January 2012 and provided a report to project management. The committee was complimentary of the PhysTEC project, noting its influence both at funded sites where work continues even after the end of funding and across the broader community of physicists and physics departments. The program's strong model of reflection, iterative learning, and continued improvement was also noted. The committee did provide criticism regarding staffing, and time management of the project, which we are considering. The committee discussed long-term goals and where the project might be headed in 5-7 years, and included recommendations for sustainability in its report. The advisory committee will meet for its third time fall of 2013 and discuss the future, evolution, and vision of the project. For a list of advisory committee members, see Appendix A.2

1.2.11 Elementary Teacher Education
Although the PhysTEC project focuses primarily on high school teacher education, it also recognizes the great need for elementary teachers who can teach physical science confidently and effectively. A growing body of evidence suggests that students’ early educational experience can profoundly influence their attitudes toward science and their decisions of whether or not to pursue a science career. Elementary teachers cannot be expected to master physics concepts at the same level as a high school teacher who specializes in the field, but research has shown that carefully constructed semester-long curricula can significantly improve both elementary teachers’ attitudes toward science and their ability to teach using inquiry. For this reason, the project has encouraged its sites to create and, if possible, require physical science courses for future elementary teachers using research-based curricula such as Physics and Everyday Thinking (PET), Physics by Inquiry (PbI), and Powerful Ideas in Physical Science (PIPS) in their physical science content courses for future elementary teachers. Most PhysTEC sites now offer one of these courses for elementary teachers, and many of the new sites are also planning to make this available.
2. PhysTEC Supported Sites

PhysTEC Supported Sites are selected colleges and universities that are developing their physics teacher preparation programs into national models 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 5 new sites joining the project, 10-14 sites continuing their funding period (some sites may petition for the third year of funding to be divided into two additional years) and 12 “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 visits to currently funded sites; video conferences, phone conversations, mid- and end-of-year reports; and meetings of site leaders at the annual PhysTEC Conference, typically in late winter, and the AAPT Summer Meeting, typically in late July. 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 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 and all PhysTEC Noyce Scholars in their first two years of teaching. Workshops include panel discussions of teachers and TIRs, discussion of assessment instruments and techniques, and sessions on interactive teaching methods and pedagogical content knowledge.

The following table lists all PhysTEC Supported Sites.

<table>
<thead>
<tr>
<th>Institution Beginning Funding Period</th>
<th>Type</th>
<th>Location</th>
<th>Project Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia State University</td>
<td>Comprehensive</td>
<td>Atlanta, GA</td>
<td>2013-2016</td>
</tr>
<tr>
<td>James Madison University</td>
<td>Comprehensive</td>
<td>Harrisonburg, VA</td>
<td>2013-2016</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>Targeted</td>
<td>Raleigh, NC</td>
<td>2013-2016</td>
</tr>
<tr>
<td>University of Central Florida</td>
<td>Comprehensive</td>
<td>Orlando, FL</td>
<td>2013-2016</td>
</tr>
<tr>
<td>University of Cincinnati</td>
<td>Comprehensive</td>
<td>Cincinnati, OH</td>
<td>2013-2016</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Institution Continuing Funding Period</th>
<th>Type</th>
<th>Location</th>
<th>Project Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona State University</td>
<td>Comprehensive</td>
<td>Phoenix, AZ</td>
<td>2012-2015</td>
</tr>
<tr>
<td>Boston University</td>
<td>Comprehensive</td>
<td>Boston, MA</td>
<td>2011-2014</td>
</tr>
<tr>
<td>California State University, Long Beach</td>
<td>Comprehensive</td>
<td>Long Beach, CA</td>
<td>2010-2013</td>
</tr>
<tr>
<td>California State University, San</td>
<td>Targeted</td>
<td>San Marcos, CA</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Institution</td>
<td>Type</td>
<td>Location</td>
<td>Start Year</td>
</tr>
<tr>
<td>------------------------------------------------------------------</td>
<td>---------</td>
<td>-------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>California State Polytechnic University, Pomona</td>
<td>Targeted</td>
<td>Pomona, CA</td>
<td>2012-2015</td>
</tr>
<tr>
<td>Central Washington University</td>
<td>Targeted</td>
<td>Ellensburg, WA</td>
<td>2012-2015</td>
</tr>
<tr>
<td>Chicago State University</td>
<td>Targeted</td>
<td>Chicago, IL</td>
<td>2010-2013</td>
</tr>
<tr>
<td>Middle Tennessee State University</td>
<td>Comprehensive</td>
<td>Murfreesboro, TN</td>
<td>2010-2013</td>
</tr>
<tr>
<td>State University of New York at Geneseo</td>
<td>Targeted</td>
<td>Geneseo, NY</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Towson University*</td>
<td>Comprehensive</td>
<td>Towson, MD</td>
<td>2010-2013</td>
</tr>
<tr>
<td>University of Alabama</td>
<td>Comprehensive</td>
<td>Tuscaloosa, AL</td>
<td>2012-2015</td>
</tr>
<tr>
<td>University of Missouri</td>
<td>Comprehensive</td>
<td>Columbia, MO</td>
<td>2012-2015</td>
</tr>
<tr>
<td>University of Wisconsin-La Crosse</td>
<td>Targeted</td>
<td>La Crosse, WI</td>
<td>2012-2015</td>
</tr>
<tr>
<td>Virginia Polytechnic Institute and State University</td>
<td>Comprehensive</td>
<td>Blacksburg, VA</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Legacy Institutions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ball State University</td>
<td>Comprehensive</td>
<td>Muncie, IN</td>
<td>2001-2008</td>
</tr>
<tr>
<td>California Polytechnic State University, San Luis Obispo</td>
<td>Comprehensive</td>
<td>San Luis Obispo, CA</td>
<td>2003-2007</td>
</tr>
<tr>
<td>Cornell University</td>
<td>Comprehensive</td>
<td>Ithaca, NY</td>
<td>2007-2011</td>
</tr>
<tr>
<td>Florida International University</td>
<td>Comprehensive</td>
<td>Miami, FL</td>
<td>2007-2010</td>
</tr>
<tr>
<td>Oregon State University**</td>
<td>Comprehensive</td>
<td>Corvallis, OR</td>
<td>2001-2004</td>
</tr>
<tr>
<td>Seattle Pacific University</td>
<td>Targeted</td>
<td>Seattle, WA</td>
<td>2006-2009</td>
</tr>
<tr>
<td>Towson University*</td>
<td>Comprehensive</td>
<td>Baltimore, MD</td>
<td>2004-2008</td>
</tr>
<tr>
<td>University of Arizona</td>
<td>Comprehensive</td>
<td>Tucson, AZ</td>
<td>2001-2008</td>
</tr>
<tr>
<td>University of Arkansas</td>
<td>Comprehensive</td>
<td>Fayetteville, AR</td>
<td>2001-2008</td>
</tr>
<tr>
<td>University of Colorado at Boulder</td>
<td>Comprehensive</td>
<td>Boulder, CO</td>
<td>2004-2008</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>Comprehensive</td>
<td>Minneapolis, MN</td>
<td>2007-2011</td>
</tr>
<tr>
<td>University of North Carolina-Chapel Hill</td>
<td>Comprehensive</td>
<td>Chapel Hill, NC</td>
<td>2007-2011</td>
</tr>
<tr>
<td>Western Michigan University</td>
<td>Comprehensive</td>
<td>Kalamazoo, MI</td>
<td>2001-2008</td>
</tr>
<tr>
<td>Xavier University of Louisiana***</td>
<td>Comprehensive</td>
<td>New Orleans, LA</td>
<td>2001-2005</td>
</tr>
</tbody>
</table>

*Towson University’s first PhysTEC project focused on elementary teacher education and its second project focused on secondary teacher education.

** Due to changes and attrition among physics faculty, Oregon State left the project prior to year four.

*** Xavier University of Louisiana suspended project activity in 2005, due to the hardship resulting from Hurricane Katrina.

### 2.1 Institutions Beginning Funding Period

In October 2012, PhysTEC solicited applications for new PhysTEC sites that would receive up to three years’ worth of funding. Similar to 2011, 2010, 2009, and 2006, the review process was modeled after that of the NSF, with a two-stage application procedure and a review panel. As in 2009, 2010, and 2011, 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 Targeted Sites that would be funded at up to $25k/year to focus on a subset of these activities. 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, a webinar on the solicitation was given by project director Ted Hodapp and moderated by co-director Monica Plisch (see http://www.phystec.org/solicitation.php for the solicitation and webinar recording).

Ultimately, 30 institutions applied to the first round—ten as Comprehensive Sites and twenty as Targeted Sites. Thirteen applicants—six Comprehensive and seven Targeted were invited to proceed to the second round of the application. At the end of the review process, the project invited Georgia State University; University of Central Florida; University of Cincinnati; and North Carolina State University to join the project. These sites will begin their projects in August 2013, and will be supported by funds from the National Science Foundation. The project was prepared to award Georgia College and State University as a targeted site but the PI announced she was leaving and we decided not to make the award.

**James Madison University** (JMU) was selected in 2011 to be a comprehensive site and chose to defer a year before beginning the project, due to the site leader being on sabbatical. JMU is a comprehensive, primarily undergraduate, public institution located in rural Harrisonburg, VA. Ranked 12th in the country for the number of physics majors among Bachelors-only physics departments, JMU has a large pool of students from which to recruit teachers. Project leaders plan to build on established programs for in-service teachers to expand and enhance the recruitment, mentoring, and retention of pre-service teachers. PhysTEC funding will support the implementation of a science pedagogy course, development of a sustainable Learning Assistant program, and hiring of a Teacher in Residence, among other related efforts.

**University of Central Florida** (UCF) is a large public university with over 59,700 students, 30% from historically underrepresented groups in its urban setting in Orlando. The UCF project has a goal to prepare 15 physics teachers during the first four years of the project and then increase the degrees awarded by five in each successive year, helping to fill the current shortage of teachers in Florida. The project leaders plan for PhysTEC to complement efforts to offer a dual teacher certification and physics major track and expand upon previous course reform of adoption of the SCALE-UP model of instruction in a large studio classroom, and the Learning Assistant program for calculus-based introductory physics courses. The UCF PhysTEC model will also build upon existing connections with K-12 teachers to recruit TIRs and potential program participants.

**Georgia State University** (GSU) is a large, growing, urban, research university with a diverse student body comprising 60% minorities of 25,000 undergraduates and 7,000 graduate students. Under-represented groups compose a significant fraction (32%) of students in introductory physics classes. GSU plans for the project to increase the number of minority physics teachers to help meet Georgia’s high need for physics teachers. Recent efforts at GSU have created multiple pathways for physics teacher preparation. Recently, a BS in physics with a concentration in education leading to teacher certification within four years was added to complement an existing Masters of Arts in Teaching (MAT) and a BS/MAT. As a comprehensive site, GSU will focus on recruitment, course reform, early teaching experiences,
and mentoring. GSU will hire a TIR to help recruit, train, and support physics teacher education students. The TIR will also teach a physics pedagogy class. Additionally, course reforms for their two-semester calculus-based introductory physics sequence and labs will include the addition of a Learning Assistant program.

North Carolina State University (NCSU) is a large, diverse, research university with more than 34,000 students and nearly 8,000 faculty and staff. NCSU is widely recognized to be a leader in STEM education and already has in place a Department of STEM Education. The Department of STEM Education contains six science education faculty and prepares future educators for middle, secondary, and post-secondary school science. NCSU recently added a BS in Physics and Master of Arts in Teaching track that allows for completion in a shorter time frame, which complements the BA in Physics that can be completed in parallel with a BS in Science Education. NCSU is a targeted site that will focus on developing a Learning Assistant program and will partner with the NSCU STEM Education Initiative to assist with course reform and LA recruiting.

University of Cincinnati (UC) is a large urban university of approximately 41,000 students with 13.6% minorities. The physics department at UC has 29 faculty and three members who specialize in education and have joint appointments in the College of Education. The goal for this comprehensive site project is to increase the number of highly-qualified high school physics teachers educated at UC to 5 or more per year through a variety of recruitment strategies, including providing flexible and accessible pathways to licensure for all STEM majors. In 2011, UC launched a BA physics degree program for students interested in teaching, which will use the PhysTEC program to boost enrollment. The UC PhysTEC model will build upon previous reform efforts including the recent implementation of a Learning Assistant program for introductory physics and longstanding professional development for in-service teachers. The Noyce Scholarship grant and Woodrow Wilson Fellowship funding will serve as recruitment mechanisms for the PhysTEC project. The project will increase access into teaching for engineering, physics, and other STEM majors; post-baccalaureate licensure students; and teachers interested in adding a supplemental license in physics. UC will offer courses specific for licensure candidates that will include Modeling Instruction and physics-specific pedagogy.

2.2 Currently Funded Institutions
The project currently funds a total of fourteen institutions. Six of the institutions began funding in 2012 and are in their first year of funding, four of the institutions began funding in 2011 while the other four began funding in 2010.

2.2.1 Institutions that Began Funding in 2012
In 2011, 35 institutions sent letters of interest for PhysTEC funding—12 as Comprehensive Sites and 23 as Targeted Sites. Eleven applicants—five Comprehensive and six Targeted—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 leaders invited Arizona State University; California State Polytechnic University at Pomona; Central Washington University; James Madison University; University of Alabama at Tuscaloosa; University of Missouri at Columbia; and University of Wisconsin at La Crosse to join the project. Six of these sites began their projects in August 2012, and are supported by funds from NSF as well as funds from the
APS campaign for the 21st century. James Madison will begin in August 2013, since the site leader is on sabbatical for the 2012-13 academic year.

**Arizona State University** (ASU), a large public university with over 70,000 students across multiple campuses in urban and suburban settings, is the primary source of science teachers for the state. The ASU project has a goal to increase the number of physics teacher graduates from 0-1 per year to 6 per year, helping to fill the current shortage of physics teachers in the Phoenix area. Project leaders have developed a four-year reformed BAE/BS dual degree program in education and physics that is in the final stages of approval. Physics courses for majors are taught using a studio format, which provides good preparation for future teachers. The new degree program includes a 400-level class in the “Modeling Instruction” method of teaching physics. Developed by ASU, Modeling is designated as exemplary for K-12 science teaching by the U.S. Department of Education. The ASU PhysTEC model also builds on well-established connections with area schools to integrate students into a professional teaching community with interactive activities for prospective, pre-service, new and experienced teachers.

**California State Polytechnic University, Pomona** (CPP) is a Hispanic Serving Institution located in the urban setting of eastern Los Angeles County with more than 20,000 undergraduates. CPP is well positioned to leverage its geographical location, demographic makeup, and pedagogical innovation into a successful physics teacher education effort. As a Targeted site, CPP will focus on recruitment, early teaching experiences, and student support. Project leaders have expanded the existing Learning Assistant program and have partnered with faculty from the college of education to provide pedagogy and content courses beginning in Fall 2013. The CPP project will also include a seminar series in teaching best practices. The Department of Physics and Astronomy has recently proposed a B.A. degree program in physics designed to allow students to fulfill the California state requirements for the physics single subject credential while obtaining a degree in physics.

**Central Washington University** (CWU) is a regional comprehensive university with about 8,500 students on its main campus and 1,500 at eight university centers located on community college campuses around the state. A joint certification math-physics teaching program has been approved to accommodate the fact that very few Washington high schools hire a full-time physics teacher. CWU also has a new Learning Assistant program, and is working on enhancing community college articulation and recruiting. As the ninth largest teacher education program in the country, CWU has the established resources and connections to significantly impact the number of certified physics teachers in Washington state and serve as a statewide model for physics teacher education.

**University of Alabama** (UA) is a doctoral granting research institution with 32,400 students. Located in a state with a severe shortage of physics teachers and access to high school physics classes, this project site is important for statewide progress. UA has existing teacher preparation program pieces in place on which to build its PhysTEC program, including a Learning Assistant program, 3 possible tracks for physics teacher certification, and a relationship with Alabama Science in Motion, which works with secondary physics teachers statewide. With PhysTEC support, project leaders plan to increase faculty and departmental collaboration, reform curriculum and courses, and mentor new physics teachers. A Teacher-in-Residence has been
hired and is teaching Alabama Science in Motion courses for future teachers, which are providing opportunities for student to engage in early teaching experiences in local high school classrooms. The project at UA is boosted by the recent award of a five-year, 8 million dollar award from the NSF MSP program, the Alliance for Physics Excellence Program (APEX). The successful PhysTEC project at UA will help alleviate the severe shortage of physics teachers in Alabama and provide a model for other teacher preparation programs in the state.

University of Missouri (UofM), the state’s flagship university, with over 33,000 students from every county, is positioned to provide a successful model for physics teacher education throughout Missouri. MU has three underutilized science education degree programs that will benefit from project plans to increase recruiting efforts, retention and early teaching experiences. A partnership with local public schools supports multiple program components, including field placements, high school recruiting tactics, and hiring a Master Teacher in Residence. Project leaders have implemented a unique, replicable model that leverages the Physics First in-service program to create district partnerships. Learning Assistants reported that the early teaching experiences in high school classrooms provided by this program solidified their commitment to teaching. The leaders plan to hold a workshop for Missouri leaders in physics education, drawing on lessons learned from implementation of the PhysTEC program.

University of Wisconsin – La Crosse (UW-L) is a public institution in western Wisconsin with a student population of approximately 9,200. With a recently hired PER specialist on faculty and programmatic changes in secondary teacher education, UW-L is in a good position to optimize PhysTEC funding. As a Targeted site, PhysTEC project leaders at UW-L aim to graduate more physics-certified teachers; provide teacher candidates with improved advising, discipline specific education coursework, and early field experiences; and provide a support network for teachers. In April 2013, UW-L received the APS Committee on Education’s award for Improving Undergraduate Physics, bringing national recognition to project leaders as models for physics education.

2.2.1 Institutions that Began Funding in 2011

In 2010, 70 institutions sent letters of interest for PhysTEC funding—34 as Comprehensive Sites and 36 as Targeted Sites. Fourteen applicants—eight Comprehensive and six Targeted—were invited to proceed to the second round of the application, and 13 submitted the secondary application materials. At the end of the review process, the project leaders invited Boston University; California State University, San Marcos; SUNY Geneseo; Virginia Tech; and Wright State University to join the project. Five of these sites began their projects in August 2011, and are supported by funds from NSF. Due to a change in leadership, Wright State University did not become a PhysTEC supported site.

Boston University (BU) is a large private institution in the Greater Boston area. In collaboration with the School of Education, the BU Physics Department has a history of educational outreach and professional development efforts in the Boston area and a strong working relationship with local school districts. PhysTEC project leaders hope to improve the perception, among both the students and the faculty, of teaching as a career, and to recruit physics teachers from both physics and engineering majors, as well as Learning Assistants. The BU project launched an active Learning Assistant program that integrated LAs into seven physics courses by the spring of
2011. It opened a new 80-seat studio classroom and has established a Noyce scholarship program. The physics department approved a physics major with education courses in 2011 to prepare students for entry into the MAT program, and there is discussion of creating a combined BA/MAT program. With the help of a TIR recruited from a high-need district, project leaders hope to provide a model for other urban institutions in New England and the U.S.

The California State University San Marcos (CSUSM) PhysTEC project is addressing the national and regional shortage of highly qualified physics teachers through recruitment, early teaching experiences, program development, and mentoring. Ongoing projects include efforts to create a Physics Education Option in the Applied Physics degree, expand their existing Learning Assistants program to a local community college partner, and facilitate early teaching experiences at local high schools. Site leader Edward Price recently received the CSUSM President’s Outstanding Faculty Award for Teaching Innovation & Excellence. CSUSM has established a professional learning community with local physics teachers and hosted the Spring 2012 meeting of the Southern California section of the American Association of Physics Teachers. Located in north San Diego County, CSUSM is a growing regional-comprehensive university that enrolls almost 9,000 undergraduates. Recently designated as a Hispanic-Serving Institution, CSUSM is culturally and ethnically diverse and representative of its surrounding region.

SUNY Geneseo is among the top five non-Ph.D. granting institutions in the U.S. in terms of the number of physics majors it graduates. In order to make it easier for future teachers to meet New York State requirements, project leaders have proposed a five-year program leading to a BA, MEd, and certification in science teaching. The project is in the process of developing and testing a model of collaborative Activity Teams, bringing together upper-level teacher candidates, first and second-year physics majors, and area high school students, with the goal of encouraging physics majors to consider careers in high school teaching. In addition, the site is developing two new courses that integrate physics content knowledge with physics pedagogy. The site has a part-time TIR whose efforts focus on recruiting, including a “Teach People Physics!” campaign on campus. Another new recruiting effort engages teacher candidates in local school districts through a “Build-it, Teach-it, Leave-it” demonstration equipment program and in-school tutoring.

Virginia Tech is a large public land-grant university in rural Southwestern Virginia with around 31,000 students. This site’s PhysTEC project takes place in the context of a university-wide initiative to promote science and math education and teacher professional development. The physics department recently introduced a BA program tailored specifically to the School of Education’s teacher certification program, which leads to a Master’s in Education degree. The project leaders’ vision is to integrate an intense educational experience for prospective teachers with a mentoring and professional development network for program alumni and other physics teachers in the state. The educational experience will include a Physics BA/MAED program with
learner-centered teaching of physics introductory courses, early field experiences, and courses in science methods and physics teaching pedagogy. Early field experiences include coaching high school teams involved in robotics competitions and developing lessons with high school teachers. The alumni network will offer regular “homecomings” on the Virginia Tech campus, continued interactions with the Virginia Tech PhysTEC program through personal contacts and online discussion forums, as well as mentoring relationships between new and experienced teachers.

The **Video Resource for Learning Assistant Development** is a project led by a team of physics education researchers at Florida International University and Seattle Pacific University, both PhysTEC legacy sites. The project was completed in 2012 and consists of a package of thematic case-based “video workshops” created to complement and enhance the Learning Assistant pedagogy course developed at the University of Colorado, Boulder, also a legacy site. The video episodes for this project showcase a variety of exemplary interactive instructional strategies. The resource provides Learning Assistants with opportunities to observe, discuss, and reflect on a variety of teaching situations, developing their pedagogical content knowledge and supporting their emerging identity as teaching professionals. In addition, the Video Resource offers users a view of other institutions’ LAs at work in transformed courses. The resource has received positive responses during presentations at conferences including the Learning Assistant Workshop and the conferences of the American Association of Physics Teachers and now has over 100 users. The videos can be accessed on the LA Video website at [http://www.ptec.org/lavideo/](http://www.ptec.org/lavideo/).

### 2.2.2 Institutions that Began Funding in 2010

In 2009, 52 institutions sent letters of interest for PhysTEC funding—26 as Comprehensive Sites and 26 as Pilot Sites. Thirteen applicants—seven Comprehensive and six Pilot (the predecessor of Targeted sites)—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 leaders invited California State University, Long Beach; Chicago State University; Middle Tennessee State University; Towson University; and the University of California, Davis to join the project. These sites began their projects in August 2010, and are supported by funds from NSF.

**California State University, Long Beach** (CSULB) is a large comprehensive university and Hispanic Serving Institution located in the Los Angeles metropolitan area, with a population of nearly 38,000 students. The CSULB PhysTEC project has focused its efforts thus far on recruiting and developing new courses for future teachers. This includes an unusual model of employing part-time TIRs and a new, highly successful pedagogical content...
knowledge course in physics instruction that students describe as invaluable. The site also hosts an open house each semester for area high school physics teachers and students, holds monthly “Physics Demo Days,” and distributes a monthly newsletter written by the TIR. Project leaders give out information cards to students in introductory courses, and follow up with communication and advising for those who indicate an interest in teaching. CSULB PhysTEC Scholars co-presented a workshop at the California Science Education Conference in October 2011. The standing room only session featured physics demonstrations illustrating force and motion concepts. CSULB is focused on sustainability to maintain funding for the TIR, LA program, and other project activities.

**Chicago State University** (CSU) is a public, urban, minority-serving institution serving around 7,000 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 going on to teach science in high-need area schools. Project leaders have focused on recruiting, both at CSU and at nearby two-year colleges. Although it does not include a full-time TIR, the project is developing an internship model called the “Teacher Immersion Institute” (TII) to enable future teachers to work with in-service teachers; project leaders published a paper in the May issue of The Physics Teacher on the CSU TII. This semester, the CSU Chemistry and Physics Department unveiled two new state of the art science classrooms. A new Science Education Website was launched in April and a filmmaker was hired to document the Science Education Program. The project is leveraging a number of ongoing education and outreach programs at the university, including a Noyce Scholarship, as well as internships with various local museums and organizations.

**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. The project is well poised within the university, as the university president has declared the goal of becoming a leader in science and math teacher preparation, and the university has been named a replication site for UTeach, the science and math teacher preparation program started at the University of Texas at Austin. Like CSULB leaders, MTSU project leaders hold regular open houses and have made a major recruiting push in introductory courses. The department hired its first PER faculty member in 2011 who is teaching a newly implemented Physics Pedagogy course. In addition, the project hired a marketing consultant to design a recruitment campaign, which was implemented in Fall 2011. MTSU produced its first PhysTEC graduate in December 2011 (pictured above, center) –
the first physics teacher in recent history from the institution. As part of UTeach, the TIR is co-teaching the STEP 1 course, an introduction to the classroom for prospective teachers.

**Towson University** is a public university in Maryland with a student population of just over 21,000. As at MTSU, upper level support for the project is strong at Towson, as administrators hope to make the university a leader in science and math teacher preparation. Towson’s current PhysTEC project builds on a number of successful existing initiatives to increase student retention, including a freshman seminar, inquiry-based introductory courses, mentoring opportunities, a Learning Assistant program, and scholarship opportunities, including a Noyce Scholarship. Project leaders are restructuring the course sequence for future teachers, and have created flexible programs that reduce the course load and time required to earn certification. A notable strength of the Towson program is the TIR, who has made an impact on faculty attitudes towards student learning and provides mentoring for students interested in teaching. In fall of 2012 Towson initiated a UTEACH program.

**University of California, Davis** (UC-Davis) and the PhysTEC project reached a mutual agreement to end the participation of UC-Davis as a PhysTEC supported site after one year. The physics department has a physics education research group and has implemented reforms of introductory courses. The MAST program on campus, a CalTeach initiative, has increased the number of qualified STEM teachers graduating from the institution. With support from PhysTEC, UC-Davis launched a Learning Assistant program, developed a Teacher Advisory Group, and initiated a focus on recruiting more physics teachers into the MAST program. UC-Davis plans to sustain and further develop these efforts with internal resources, and there is interest in hiring a part-time Teacher in Residence. UC-Davis will remain a PhysTEC Member Institution, committed to the mission of improving the education of future physics teachers.

### 2.3 Legacy Sites

The initial PhysTEC site selection 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. In October 2006, Cornell University, Florida International University, the University of Minnesota, and the University of North Carolina at Chapel Hill were also chosen to join the project. Each legacy site has made significant contributions to the project, and has sustained elements of their teacher preparation program beyond PhysTEC funding. The site descriptions below are of those that started funding during the previous PhysTEC grant but overlapped with the current PhysTEC II grant. More detailed descriptions of all PhysTEC Legacy Sites can be found at [www.phystec.org/institutions](http://www.phystec.org/institutions).

**Cornell University**’s PhysTEC project leaders report that the project has greatly improved attitudes toward teaching careers in the physics department, among both students and faculty. Through extensive advertising and targeted one-on-one conversations, Cornell TIRs have substantially increased the number of students considering physics teaching. Cornell’s Undergraduate Teaching Assistant (UTA) program (similar to a Learning Assistant program)
launched with eight undergraduates in Spring 2008, and has expanded to include 19 UTAs in Spring 2011. 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, and one of the TIRs hired during the project continued on as Visiting Master Teacher. In March 2011, site leader Robert Thorne was selected as a Cornell Stephen H. Weiss Presidential Fellow, “which recognizes faculty for sustained records of effective, inspiring and distinguished teaching of undergraduate students and of contributions to undergraduate education.” Cornell has sustained strong support for physics teacher preparation despite the Education Department deciding to drop all programs for teacher certification at the university. Students who want to become teachers are directed to high quality teacher certification programs.

**Florida International University** (FIU) project leaders launched a Learning Assistant program in 2007 that has spread to the Math, Chemistry, and Earth Sciences departments, and now attracts over 100 applicants per semester. Physics Learning Assistants learn the highly regarded Modeling approach to teaching, developed at Arizona State University. Science and math teacher certification is done in the disciplinary departments, as of Fall 2009. In 2008 FIU graduated its first physics teacher in a decade, and has graduated one per year since then, with more in the pipeline. The university is among the institutions graduating the most Hispanic physics majors in the country, and is poised to provide the lion’s share of highly qualified physics teachers to the southern tip of Florida, and especially to the Miami-Dade County Public Schools, one of the largest and most diverse districts in the country.

**Seattle Pacific University** (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 (VMT), a part-time hire who takes 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. Thanks to effective recruiting and advising, as well as a departmental culture that strongly values teaching, SPU has recruited a large number of PhysTEC Noyce scholars, with a total of ten over the first three years of the program.

**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 the program has shown potential as a means to increase major retention as well as recruit teachers. 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. Minnesota extended its PhysTEC MOU for a fourth year to hire a new TIR using internal funds that match project funds 3:1, and continued employing a TIR in 2011-2012 and 2012-13 to teach the Physics and Everyday Thinking (PET) course for elementary teachers. Project leaders are also looking for ways to sustain their Learning Assistant program. In 2011, site leader Cindy Cattell received the University of Minnesota George W. Taylor Award for Distinguished Service.
The University of North Carolina at Chapel Hill (UNC) established a program called UNC-BEST (UNC Baccalaureate Education in Science and Teaching), which allows students to graduate with a science degree and teaching certification in four years. It began with the Department of Physics and Astronomy and the Department of Biology, and 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. UNC employs a Physics Education Research (PER) specialist, who has done much of the development for the physics methods course that students interested in teaching take. UNC is a PhysTEC Noyce site, and has hired a VMT to take on some of the roles the TIR previously filled.

2.4 PhysTEC Noyce Program
In Fall 2008, the PhysTEC project received an award through the NSF’s Robert Noyce Teacher Scholarship Program to support future physics teachers at six PhysTEC sites. This was 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). Now in its fifth year of funding, the PhysTEC Noyce program selected four students from three PhysTEC sites to receive scholarships for the 2013-2014 academic year. Of these, one is a returning scholar, and three are new applicants. Three will be post-baccalaureate students and one will be a senior in 2013-2014. This brings the total cohort of PhysTEC Noyce scholars to twenty-seven.

The PhysTEC Noyce program supports Visiting Master Teachers (VMTs) to mentor PhysTEC Noyce scholars. The program also provides opportunities to scholars to participate in physics education research and research-based professional development workshops.

More information about the PhysTEC Noyce Program is available at [www.phystec.org/noyce](http://www.phystec.org/noyce).

2.5 PhysTEC Endorsement
The project now offers “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 submit an application, and partially fund a site visit by project leaders. Endorsed institutions enjoy many of the same benefits as funded (present and past) sites, including the potential to be included in future projects, being featured in conferences and workshops, and connection to a national network of PhysTEC sites.

In 2010, Rutgers University became the first PhysTEC Endorsed Site. The Rutgers physics and physical science teacher education program, led by Eugenia Etkina, graduates 6-10 physics teachers per year. The program focuses on preparing teachers of physics or physical science who are knowledgeable in the content and processes of physics, who can engage students in active learning of physics using scientific inquiry, and who can assess student progress in ways that improve learning.

3. Dissemination and Advocacy
The PhysTEC project views dissemination of project successes and advocacy for physics faculty involvement in teacher education as a central part of its mission, and essential for progress on
increasing the number of highly qualified physics teachers. 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 Supported Sites, the project is also building a broad coalition of PhysTEC Member 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.

Previously this Coalition was known as PTEC, but the project decided to phase out this acronym.

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 283 member institutions.
The graph above shows growth in coalition membership over the past nine years, and the map below shows their geographical distribution. The coalition members include around 30% of all physics departments granting bachelor’s degrees, and there is at least one member institution in all but 2 states (Alaska and Delaware), with coverage roughly corresponding to population density. Data collected from coalition members suggest that they graduate between 200 and 300 physics teachers per year. A complete list of coalition members can be found in Appendix C of this report.

![Map of Physics Teacher Education Coalition Member Institutions](image)

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.

### 3.1.2 Conferences and Workshops

PhysTEC conferences and workshops are the most significant ways 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 for the relationships that are built through informal networking.
3.1.2.1 Annual PhysTEC Conference
Since 2005, the PhysTEC Conference has been held annually in late winter or spring, and has attracted many of the leaders in physics teacher preparation from around the country. Since 2009 we have co-located conferences to coincide with other meetings to attract people outside of the standard community. The format typically includes two days of 1.5-hour workshops and panel discussions in three or four parallel tracks, lunchtime plenary speakers, opening and closing sessions, and a poster session with a reception. 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 table below shows past and future conference locations and attendance. The sites for the PhysTEC Conference are chosen to engage a larger audience and reach out to a broad cross-section of the physics community.

The 2013 PhysTEC Conference was held March 16-17 in Baltimore, MD in conjunction with the APS March Meeting. The conference theme, “Preparing the Next Generation of Physics Teachers,” provided a framework for sessions relating to course reform, induction and mentoring, and innovative practice, among others. The American Chemical Society partnered with PhysTEC and included four sessions relating specifically to chemistry teacher preparation. This year we had a very high return rate (80%) for conference evaluations. Overall attendees rated the sessions an average of 4.2 out of 5, where “1” indicated not at all useful and “5” indicated extremely useful. Many noted that the networking opportunities were the most valuable part of the conference and provided the rare occasion for faculty, physics education researchers, and administrators to interact and exchange ideas. The conference schedule and select presentations are available at www.ptec.org/conferences/2013.

The 2014 PhysTEC Conference will be held May 19-20, in Austin, TX in conjunction with the UTeach Conference and the 2015 PhysTEC Conference will be held January 2-4, in San Diego, CA in conjunction with the winter AAPT Meeting.

3.1.2.2 Topical Workshops
The project has held six topical workshops focusing on particular elements of teacher preparation. Most recently, in October 2012, the project sponsored its fourth workshop focusing on the University of Colorado's Learning Assistant program (the first took place in October 2007). The two-day workshop was led by faculty and staff at CU-Boulder, and provided participating faculty from other institutions with information they need to set up a successful Learning Assistant (LA) program. Participants observed learning assistant tutorials, participated in the pedagogy class that first-year Learning Assistants take, and received copies of the materials developed by CU-Boulder faculty and staff. Forty-one faculty and staff representing 24 different PhysTEC Member Institutions attended the workshop. Participants most appreciated

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>San Diego, CA</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Austin, TX</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Baltimore, MD</td>
<td>120</td>
</tr>
<tr>
<td>2012</td>
<td>Ontario, CA</td>
<td>124</td>
</tr>
<tr>
<td>2011</td>
<td>Austin, TX</td>
<td>120</td>
</tr>
<tr>
<td>2010</td>
<td>Washington, DC</td>
<td>100</td>
</tr>
<tr>
<td>2009</td>
<td>Pittsburgh, PA</td>
<td>108</td>
</tr>
<tr>
<td>2008</td>
<td>Austin, TX</td>
<td>117</td>
</tr>
<tr>
<td>2007</td>
<td>Boulder, CO</td>
<td>112</td>
</tr>
<tr>
<td>2006</td>
<td>Fayetteville, AR</td>
<td>85</td>
</tr>
<tr>
<td>2005</td>
<td>Muncie, IN</td>
<td>82</td>
</tr>
</tbody>
</table>
learning more from the LAs’ perspective, having the opportunity to network, and picking up practical details about running an LA program. A number of attendees anticipated plans to implement LA programs in upcoming semesters, including launching pilot programs, looking for funding, and starting pedagogy courses. The workshop schedule and selected presentations are available at [www.ptec.org/conferences/cula12](http://www.ptec.org/conferences/cula12).

On June 10-12, 2012 the project co-sponsored a workshop on “Building a Thriving Undergraduate Physics Program” at the American Center for Physics in College Park, MD to assist departments in developing strategies for increasing the number of physics majors and improving the vitality of undergraduate physics programs. Faculty members from public universities as well as private minority-serving institutions were invited to discuss and plan solutions with educational leaders who have faced and overcome similar issues.

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Boulder, CO</td>
<td>University of Colorado at Boulder’s Learning Assistant Program workshop <a href="http://www.ptec.org/conferences/cula13">www.ptec.org/conferences/cula13</a></td>
</tr>
<tr>
<td>2012</td>
<td>Boulder, CO</td>
<td>University of Colorado at Boulder’s Learning Assistant Program workshop <a href="http://www.ptec.org/conferences/cula12">www.ptec.org/conferences/cula12</a></td>
</tr>
<tr>
<td>2012</td>
<td>College Park, MD</td>
<td>Workshop on “Building a Thriving Undergraduate Physics Program” at the American Center for Physics <a href="http://www.ptec.org/conferences/enrollment/">http://www.ptec.org/conferences/enrollment/</a></td>
</tr>
<tr>
<td>2010</td>
<td>Boulder, CO</td>
<td>University of Colorado at Boulder’s Learning Assistant Program workshop <a href="http://www.ptec.org/conferences/cula10/">http://www.ptec.org/conferences/cula10/</a></td>
</tr>
<tr>
<td>2009</td>
<td>Pittsburgh, PA</td>
<td>Workshop in partnership with the Association of Public and Land-grant Universities in conjunction with the PhysTEC Conference <a href="http://www.ptec.org/events/event.cfm?ID=5">http://www.ptec.org/events/event.cfm?ID=5</a></td>
</tr>
<tr>
<td>2007</td>
<td>Boulder, CO</td>
<td>University of Colorado at Boulder’s Learning Assistant program workshop <a href="http://www.ptec.org/conferences/CULA/">http://www.ptec.org/conferences/CULA/</a></td>
</tr>
<tr>
<td>2006</td>
<td>College Park, MD</td>
<td>Reformed Teaching Observation Protocol[^15], at the American Center for Physics</td>
</tr>
</tbody>
</table>

3.1.2.3 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. Most recently, in February 2012, the project sponsored a regional conference in Ontario, CA with the Math and Science Teacher Initiative (MSTI) at the California State University and CalTeach at the University of California. This was the first meeting of these STEM education initiatives of the two major university systems in California, and provided the opportunity for education leaders to share ideas on recruitment, retention, and transforming the undergraduate education of future STEM teachers. It also introduced CSU and UC institutions to PhysTEC programs already underway in California and across the U.S.

Past regional conferences are listed in the table above. For more information on all conferences, see [www.ptec.org/conferences](http://www.ptec.org/conferences)

### Table 4. PhysTEC Regional Conferences

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Ontario, CA</td>
<td>PhysTEC Regional Conference of MSTI and CalTeach</td>
</tr>
<tr>
<td>2008</td>
<td>Seattle, WA</td>
<td>PTEC Northwest Regional Conference</td>
</tr>
<tr>
<td>2007</td>
<td>Chapel Hill, NC</td>
<td>North Carolina Conference</td>
</tr>
</tbody>
</table>

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](http://www.phystec.org)) is organized around the “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 sites’ 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](http://www.ptec.org)) 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 to assemble and highlight high-quality materials in the collection. The PTEC website gets over 3,500 visits per month and is updated continuously.

The PhysTEC website will be merged with the PTEC website as part of phasing out the PTEC acronym. The combined PhysTEC-PTEC website will use the current PTEC design and structure, but will combine content from both sites and will be hosted on APS servers. The
The project will retain both URLs, and point all traffic to the merged site. The project expects to finish merging the PhysTEC and PTEC websites in 2013.

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. Other email lists, including ones for TIRs and PhysTEC teachers, serve mostly to help disseminate announcements for events and opportunities.

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 realized 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 Report on Teacher Education in Physics (T-TEP) was published in December 2012. The report is available to download at http://www.ptec.org/webdocs/TaskForce.cfm. A copy will be sent 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. Task Force members and project leaders have a number of talks on the outcomes of the project. Presentations related to the T-TEP report can be accessed at http://www.ptec.org/webdocs/Presentations.cfm.

More information and a summary of the Task Force’s findings and recommendations are available at www.ptec.org/TaskForce, including a list of Task Force members.

3.4 Books on Teacher Preparation
The project sponsored a book of peer-reviewed papers on physics teacher preparation, Teacher Education in Physics: Research, Curriculum, and Practice, which was published jointly by APS and AAPT in December 2011. The book includes five new reports on cutting-edge research and practice, as well as selected reprints of seminal papers. Printed copies have been distributed to the chairs of all physics departments in the United States, and the book is freely available online. Publication in either of the peer-reviewed journals Physical Review Special Topics-Physics Education Research or the American Journal of Physics was a prerequisite for inclusion in the book. Edited by David Meltzer of Arizona State University and Peter Shaffer of University of Washington, the book features one- to two-page executive summaries of each article. Additional details and a free pdf copy are available at www.ptec.org/webdocs/PtecBook.cfm. Limited hard copies are also available.

In the past year, the project has solicited manuscripts for a second book of peer-reviewed work, titled Effective Practices in Preservice Physics Teacher Education: Recruitment, Retention, and Preparation. This book, co-edited by Eric Brewe and Cody Sandifer, seeks to provide a practical guide to innovative, state-of-the art programs in physics teacher preparation. Manuscript proposals were solicited in February 2013, and the editors received 32 submitted chapters and five invited chapters. PhysTEC funded sites submitted 13 proposals and PhysTEC Coalition institutions submitted 21. Full manuscripts are expected to be submitted by September 2013. The
book is scheduled for publication in 2015 and, like the first book, will be distributed to all physics chairs in the United States and will be distributed free online.

3.5 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.

3.5.1 Annual PhysTEC Newsletter
In Fall 2011 the project published the fifth edition of its newsletter PhysTEC News. The goal of this publication is to create a high-quality publication to represent the project to potential project partners, sponsoring society board members, university administrators, faculty, and donors. The newsletter is given to the APS and AAPT Executive Boards, and copies are mailed to all Coalition and PhysTEC institutions as well as the chairs of every U.S. physics department that grants a bachelor’s degree. The newsletter also serves as the top giveaway at the project’s exhibition booth. The most recent newsletter was published in Fall 2012, and the next newsletter is planned for Fall 2013.

3.5.2 APS News
Articles about the project are periodically published in APS News, APS’s monthly newspaper that goes out to its 50,000+ members. The January 2012 edition included an article about the PhysTEC project at Middle Tennessee State University. A bimonthly feature called the “Education Corner” also frequently features news about the project.

3.5.3 APS Forum on Education (FEd) Newsletter
Since 2005, the APS Forum on Education Newsletter has contained a section on teacher preparation. Almost 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. Most recently the Spring 2013 edition included articles by project leaders at Virginia Tech, Towson, and CSUSM.

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

3.5.5 Status Reports
The project publishes status reports approximately every three to four months. These are sent to PhysTEC Member Institutions, partner society heads, and NSF Program Officers, and are placed on the PhysTEC website at http://www.phystec.org/status/index.php

3.5.6 Videos
Recognizing the importance of digital media, especially for the generation of students who are in college now, the project has created three videos designed to encourage students to consider physics teaching careers. The first was a five-minute video profile of a graduate of the Cal Poly teacher education program. The second, a 3.5-minute video entitled “Teach Physics,” features four young physics teachers who talk about what excites them about their jobs, as well as
extensive footage from these teachers’ classrooms. The third, a two-minute video promoting the Robert Noyce Teacher Scholarship Program, is intended for potential scholarship applicants. The organizers of the 2010 Noyce PI meeting contracted with the project to produce this video, and gave a copy to all participants. All three videos can be seen, downloaded, or embedded at www.phystec.org/video, and DVD copies were created and distributed for the latter two.

3.6 Presence at AAPT and APS Meetings
In order to reach out to a greater fraction of the physics faculty around the country, the project has a significant presence at AAPT and APS meetings. The project staffs an exhibit booth at these meetings, and sponsors or co-sponsors sessions, particularly at AAPT meetings.

4. Collaborations

In order to maximize its impact, the PhysTEC project seeks collaborations with a wide range of partnering organizations and efforts.

4.1 UTeach
UTeach, a highly successful science and math teacher preparation program that began at the University of Texas at Austin, has been a frequent collaborator with PhysTEC. The program was strongly represented at the 2010 Conference, with two workshops devoted to the UTeach replication effort. The 2011 PhysTEC Conference was held jointly with the UTeach Institute’s annual conference in Austin, TX, allowing attendees from both conferences to attend sessions of either conference. Next year’s PhysTEC conference is similarly being planned in conjunction with the 2014 UTeach conference. A collaborative effort to bring PhysTEC reforms to the physics departments of UTeach replication sites is currently being pursued by PhysTEC and the National Math and Science Initiative, an organization responsible for funding UTeach replication nationally. The organizations intend to develop mechanisms to either work within the existing UTeach funding construct, or seek external funding to bring these ideas to physics departments ready to advance physics teacher education. A complimentary effort in chemistry through the Chemistry Teacher Education Coalition is also being discussed.

4.2 The American Chemical Society
The project has also helped inspire the American Chemical Society (ACS) to launch a parallel effort for chemistry teachers. To assist this effort, the PhysTEC Conference has featured sessions on chemistry teacher preparation and intends to continue this in 2014. Mary Kirchhoff, Director of Education for the American Chemical Society, presented the lunchtime plenary at the 2012 PhysTEC Conference. In collaboration with the ACS, the 2013 PhysTEC conference featured multiple sessions on chemistry teacher preparation. ACS is in the process of forming the Chemistry Teacher Education Coalition (CTEC), and has invited institutions to sign onto a statement in support of chemistry departments engaging in teacher education; both of these initiatives were modeled after those of PhysTEC. Monica Plisch and Theodore Hodapp both are serving on the CTEC National Advisory Board to help inform the ACS effort as it gets off the ground.

4.3 The Association of Public and Land-grant Universities (APLU)
The project continues to work with the APLU, whose Science and Mathematics Teacher Imperative (SMTI) is engaging university administrations to take pledges to increase the number of science and math teachers educated at their institutions. The APLU collaboration includes presenting at their annual SMTI meeting, pursuing joint dissemination projects, and consulting with their project management to promote collective actions on campuses. The SMTI has developed the Analytic Framework (AF), which has begun the process of creating and organizing key components, goals, objectives and strategies that are particular to science and mathematics teacher preparation. More information and a free copy of the AF may be found at: http://www.aplu.org/page.aspx?pid=2182.

4.4 The California State University System
In 2012, PhysTEC and California State University submitted an application to 100Kin10, a multi-partner organization that aims to train 100,000 teachers over the next ten years. An article on the California Council on Science and Technology website featured the partnership between PhysTEC and CSU, highlighting its goals to address the severe shortages of math and science teachers in California, including high school physics teachers. This dovetails with the 100Kin10 commitment by the project to expand PhysTEC to an additional 50 institutions over the next 10 years. While the funding application was not successful, it underscores the potential for PhysTEC to work with state university systems to reform physics teacher education on a larger scale.

The project also collaborated with CSU’s Math and Science Teacher Initiative (MSTI) to hold the PhysTEC Regional Conference of MSTI and CalTeach, detailed in section 3.1.2.3 Regional Conferences above, in February 2012.

APPENDIX A: Project Personnel

A.1 PhysTEC Management Team

A.1.1 Present Members

• Theodore Hodapp, PI (2004-2013), Director of Education and Diversity, APS. Hodapp is the primary contact for 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 30% of his time on the PhysTEC project.

• Monica Plisch, (2007-2013; co-PI 2009-2013) Associate Director of Education and Diversity, APS. Plisch manages the overall project activities. Plisch participates in site visits and works with Hodapp to manage other aspects of the project, spending around 60% of her time on the PhysTEC project.

• Renee Michelle Goertzen (2013) Education Programs Manager, APS. Goertzen manages Coalition activities, including the annual PhysTEC Conference. She spends roughly 50% of her time on the PhysTEC project.

• Beth Cunningham, (co-PI 2010-2013) Executive Officer, AAPT. Cunningham coordinates AAPT’s involvement in the project.
• **Robert Hilborn**, (2012-2013) Associate Executive Officer, AAPT. Hilborn assists with AAPT’s involvement in the project.

• **Renée Royal**, PhysTEC Project Coordinator (2013), APS. Renée manages the day-to-day operations of PhysTEC, including coordinating project meetings, updating project websites, managing project and budgetary data, and handling a variety of other tasks.

• **Jon Anderson**, TIR and Mentoring Consultant (2009-2013). Anderson is responsible for coordinating TIR activities and outreach to PhysTEC teachers. He participates in Project Management Team meetings.

• **Rachel Scherr**, (2012-2013). Project Consultant. Scherr is conducting the Sustainability Study and the Formative Assessment effort.

• **Gabriel Popkin**, Consultant (2011-2013; Project Manager 2007-2011), APS. Popkin currently writes articles for the project and manages other tasks as assigned. Previously he managed many of the day-to-day project operations.


**A.1.2 Past Members**

• **Jacob Clark Blickenstaff**, (2011-2013) Teacher Education Programs Manager, APS. Blickenstaff managed Coalition activities, including the annual PhysTEC Conference. He also managed the PhysTEC Noyce project. He spent roughly 50% of his time on the PhysTEC project. Jacob left the role of Teacher Education Programs Manager in May of 2013 and will continue to manage the PhysTEC Noyce project through August 2013.

• **Sara Webb**, PhysTEC Project Coordinator (2010-2012), APS. Webb managed the day-to-day operations of PhysTEC, including coordinating project meetings, updating project websites, managing project and budgetary data, and handling a variety of other tasks.

• **Bushraa Khatib**, (2011-2012), APS Bridge Program Coordinator, APS. Khatib stepped in to assist with the day-to-day operations of PhysTEC while another staff member was on leave.

• **Warren Hein**, (2001-2010; co-PI 2005-2007, 2008-2010), Executive Officer Emeritus, AAPT. Hein now leads aspects of the PhysTEC Noyce project including the VMT program. Prior to his retirement, he coordinated AAPT’s involvement in the project.

• **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.

• **Edward Lee**, Project Associate, APS (2001-2010).

• **Shirley Wilson**, Project Assistant, APS (2009-2010).

• **Jack Hehn**, co-PI (2001-2009), Director of Education Programs, American Institute of Physics.

• **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.

**A.2 Advisory Committee**
A.2.1 Present members
- 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
- JoAnne Vasquez, Vice President, Helios Foundation

A.2.2 Past Members
The project is in the process of replacing one of these members.
- Carlos Contreras, U.S. Education Manager, Intel Corporation
- Kimberly Mitchell, Senior Program Officer, Bill and Melinda Gates Foundation
## 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>2013</td>
<td>Khatib</td>
<td>Attendees Flock to Annual PhysTEC Conference</td>
<td>APS News, May 2013</td>
</tr>
<tr>
<td>2013</td>
<td>APS Staff</td>
<td>PhysTEC Project Synopsis</td>
<td>April 2013</td>
</tr>
<tr>
<td>2013</td>
<td>APS Staff</td>
<td>PhysTEC Project Synopsis</td>
<td>October 2012</td>
</tr>
<tr>
<td>2012</td>
<td>APS Staff</td>
<td>PhysTEC Project Synopsis</td>
<td>March 2012</td>
</tr>
<tr>
<td>2012</td>
<td>Popkin</td>
<td>Middle Tennessee State University Takes on Physics Teacher Preparation</td>
<td>APS News, January 2012</td>
</tr>
<tr>
<td>2012</td>
<td>Popkin</td>
<td>University of Arkansas Case Study: Teaching, Research, and Advising</td>
<td>APS Forum on Education Newsletter, Spring 2012</td>
</tr>
<tr>
<td>2011</td>
<td>Hodapp</td>
<td>The Economics of Education: Closing Undergraduate Physics Programs</td>
<td>APS News, December 2011</td>
</tr>
<tr>
<td>2011</td>
<td>Popkin</td>
<td>Four Funded Sites Join APS Teacher Education Project</td>
<td>APS News, June 2011</td>
</tr>
<tr>
<td>2011</td>
<td>Popkin</td>
<td>Minority Serving Institutions Take on Teacher Preparation</td>
<td>CSWP &amp; COM Gazette (Pg. 7), Spring 2011</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td>PhysTEC Project Synopsis</td>
<td>December 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin (editor)</td>
<td>PhysTEC News</td>
<td>PhysTEC News, Fall 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td>PhysTEC Scholarship Program for Future Physics Teachers</td>
<td>APS Forum on Education Newsletter, Summer 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td>Teacher Education Program Adds Five New Sites</td>
<td>APS News, April 2010</td>
</tr>
<tr>
<td>2010</td>
<td>Popkin</td>
<td>Teacher Preparation Conference Focuses on Diversity</td>
<td>APS News, April 2010</td>
</tr>
<tr>
<td>2009</td>
<td>Popkin</td>
<td>APS-Led Project Receives $6.5M NSF Grant</td>
<td>APS News, October 2009</td>
</tr>
</tbody>
</table>
## B.2 PhysTEC Institution Publications

<table>
<thead>
<tr>
<th>Institution</th>
<th>Year</th>
<th>Authors</th>
<th>Title</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston University</td>
<td>2012</td>
<td>Jenkins, J.</td>
<td>Boston University PhysTEC Program</td>
<td>AAPT-NES March Newsletter</td>
</tr>
<tr>
<td>UC Davis</td>
<td>2011</td>
<td>Webb, D.</td>
<td>PhysTEC Program at the University of California, Davis</td>
<td>APS Forum on Education Newsletter, Spring 2011.</td>
</tr>
<tr>
<td>Middle Tennessee State</td>
<td>2010</td>
<td>Henderson, R.</td>
<td>Physics Teaching Embraced at MTSU with the help of PhysTEC</td>
<td>APS Forum on Education Newsletter, Fall 2010.</td>
</tr>
<tr>
<td>University</td>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
<td>Conference/Journal</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
<td>--------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------</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](http://www.phystec.org/presentations).
## B.3 PhysTEC Press

<table>
<thead>
<tr>
<th>Title</th>
<th>Publication</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly trained physical science teachers needed to educate students for high tech economy</td>
<td>The Hill’s Congress Blog, April 25, 2013</td>
<td>April 25, 2013</td>
</tr>
<tr>
<td>Physics department works to produce more teachers</td>
<td>State Press, Arizona State University.</td>
<td>November 6, 2012</td>
</tr>
<tr>
<td>CSU Partners with PhysTEC to Boost California Science Teacher Production</td>
<td>California Council on Science and Technology Spotlight</td>
<td>March 15, 2012</td>
</tr>
<tr>
<td>Wanted: One Good Physics Teacher</td>
<td>Boston University Today</td>
<td>February 1, 2012</td>
</tr>
<tr>
<td>CWU Receives $65K to Improve Physics Education</td>
<td>Central Washington University News</td>
<td>October 31, 2012</td>
</tr>
<tr>
<td>UA Receives a $1.6 Million Grant for Physics Education Improvements in High Schools</td>
<td>University of Alabama News</td>
<td>October 25, 2012</td>
</tr>
<tr>
<td>Preparing Chemistry Teachers For The Next Generation Science Standards</td>
<td>Chemical &amp; Engineering News</td>
<td>December, 2011</td>
</tr>
<tr>
<td>PhysTEC prepares students for future as physics educators</td>
<td>The LAMRON</td>
<td>October 27, 2011</td>
</tr>
<tr>
<td>National initiatives recruit and retrain science teachers</td>
<td>Physics Today</td>
<td>January, 2011</td>
</tr>
<tr>
<td>CSU Selected to be a National Model for the Preparation of High School Physics Teachers</td>
<td>CSU News</td>
<td>October, 2010</td>
</tr>
<tr>
<td>Cornell producing future high school physics teachers</td>
<td>Cornell University Chronicle</td>
<td>November 30, 2009</td>
</tr>
<tr>
<td>FIU’s New Approach to Teaching Sends Scientists into the Classroom</td>
<td>News@FIU</td>
<td>November 30, 2009</td>
</tr>
<tr>
<td>A genuine teaching experience</td>
<td>Physics Today</td>
<td>October, 2009</td>
</tr>
<tr>
<td>PhysTEC Integrates Physics, Education</td>
<td>NSTA Reports</td>
<td>January, 2009</td>
</tr>
</tbody>
</table>
APPENDIX C: PhysTEC Member Institutions as of May 15, 2013

Abilene Christian University
Adrian College
Anderson University
Andrews University
Angelo State University
Arizona State University
Arkansas State University
Armstrong Atlantic State University
Auburn University
Augusta State University
Augustana College
Ball State University
Bemidji State University
Benedictine University
Berry College
Boise State University
Boston University
Bowdoin College
Bridgewater State University
Brigham Young University
Brigham Young University-Idaho
Buffalo State University
Butler University
California Polytechnic State University, Pomona
California Polytechnic State University, San Luis Obispo
California State University, San Marcos
California State University, Chico
California State University, East Bay
California State University, Fresno
California State University, Long Beach
California State University, Sacramento
California University of Pennsylvania
Calvin College
Canisius College
Casper College
Central Washington University
Chatham University
Chicago State University
Chuvashe State Teacher Training University
Citadel, The
Claffin University
Clarion University
Cleveland State University
Coastal Carolina University
Colgate University
Colorado Christian University
Columbus State University
College of New Jersey, The
Connecticut College
Cornell University
DePaul University
Dodge City Community College
East Carolina University
East Central University
East Stroudsburg University
Eastern Illinois University
Eastern Kentucky University
Elon University
Emporia State University
Fairmont State University
Florida A & M University
Florida Atlantic University
Florida Gulf Coast University
Florida International University
Florida State University
Fort Hays State University
Francis Marion University
George Washington University
Georgia Southern University
Georgia College & State University
Green River Community College
Grove City College
Hamline University
Harvey Mudd College
Hillsdale College
Hiram College
Hofstra University
Hope College
Howard University
Illinois State University
Indiana University of Pennsylvania
Indiana University South Bend
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
Kent State University
King College
Lawrence Technological University
Lehman College, City University of New York
Lincoln University
Lone Star College-North Harris
Longwood University
Louisiana State University
Loyola University Chicago
Loyola University Maryland
Manhattan College
McKendree University
McNeese State University
Medaille College
Mercer University
Michigan State University
Middle Tennessee State University
Millersville University
Minnesota State University Moorhead
Misericordia University
Missouri University of Science and Technology
Monmouth College
Morningside College
National Superconducting Cyclotron Laboratory
Nebraska Wesleyan University
New Mexico State University
North Carolina A&T State University
North Carolina State University
North Dakota State University
Northern Illinois 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
Pomona College
Portland State University
Purdue University
Radford University
Randolph College
Research Corporation for Science Advancement
Rensselaer Polytechnic Institute
Rochester Institute of Technology
Rowan University
Rutgers, the State University of New Jersey
Saint Anselm College
Saint Joseph's University
Saint Mary's College
Saint Michael's College
Salisbury University
San Antonio College
San Francisco State University
San Jacinto College Central
San Jose State University
Science Foundation Arizona
Seattle Pacific University
Siena College
Skidmore College
Slippery Rock University
Smith College
Sonoma State University
South Dakota State University
Southeastern Louisiana University
Southern Illinois University Edwardsville
Southern Methodist University
Southern Oregon University
Southern University and A&M College
Southwestern Oklahoma State University
Spelman College
St. Ambrose University
St. John's University
St. Joseph's University
Stony Brook University
SUNY Cortland
SUNY Fredonia
SUNY Geneseo
SUNY Oneonta
Tarleton State University
Tennessee Technological University
Texas A&M University
Texas A&M University-Commerce
Texas Southern University
Texas State University-San Marcos
Towson University
Trinity Christian College
Truman State University
Tufts University
Tuskegee University
Union Graduate College
Union University
University of Alabama
University of Alabama at Birmingham
University of Arizona
University of Arkansas
University of California at Riverside
University of California, Berkeley
University of California, Davis
University of California, Santa Cruz
University of Central Arkansas
University of Central Florida
University of Cincinnati
University of Colorado at Boulder
University of Colorado at Colorado Springs
University of Connecticut
University of Education, Winnega
University of Florida
University of Hawaii at Hilo
University of Hawaii at Manoa
University of Houston
University of Houston Clear Lake
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 Dartmouth
University of Massachusetts-Boston
University of Memphis
University of Michigan, Ann Arbor
University of Michigan, Dearborn
University of Minnesota

University of Mississippi
University of Missouri-Columbia
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 North Florida
University of North Texas
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 Portland
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 Brownsville
University of Texas at El Paso
University of Texas at San Antonio
University of Texas at Tyler
University of Texas-Pan American
University of Toledo
University of Washington
University of West Georgia
University of Wisconsin-La Crosse
University of Wisconsin-Madison
University of Wisconsin-Milwaukee
University of Wisconsin-River Falls
University of Wisconsin-Stevens Point
University of Wisconsin-Whitewater
University of Wyoming
Vassar College
Vincennes University
Virginia Tech
Wayne State University
Weizmann Institute of Science
<table>
<thead>
<tr>
<th>University Name</th>
<th>University Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Chester University of Pennsylvania</td>
<td>Winona State University</td>
</tr>
<tr>
<td>West Virginia State University</td>
<td>Winston-Salem State University</td>
</tr>
<tr>
<td>West Virginia University</td>
<td>Wittenberg University</td>
</tr>
<tr>
<td>Western Illinois University</td>
<td>Women's Christian College</td>
</tr>
<tr>
<td>Western Kentucky University</td>
<td>Worcester Polytechnic Institute</td>
</tr>
<tr>
<td>Western Michigan University</td>
<td>Wright State University</td>
</tr>
<tr>
<td>Western Washington University</td>
<td>Youngstown State University</td>
</tr>
<tr>
<td>Wheeling Jesuit University</td>
<td>Xavier University of Louisiana</td>
</tr>
<tr>
<td>Wichita State University</td>
<td></td>
</tr>
</tbody>
</table>