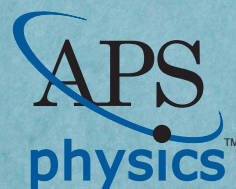




# HISTORY OF APS INVOLVEMENT IN EDUCATION

*By Gabriel Popkin*

ASSOCIATION OF  
PUBLIC AND  
LAND-GRANT  
UNIVERSITIES



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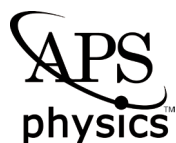
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## Foreword

Howard J. Gobstein  
Executive Vice President  
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In 2008, the National Science Foundation awarded a Mathematics and Science Partnership RETA (Research, Evaluation and Technical Assistance) grant to the Association of Public and Land-grant Universities (APLU) to “Promote Institutional Change to Strengthen Science and Mathematics Teacher Preparation.” It was our hypothesis that change in higher education could be promoted effectively by a simultaneous top-down and bottom-up approach. APLU is a membership organization composed of 186 public and land-grant research universities represented by their Presidents/Chancellors and Provosts—the top-down component. Our partner in this project was the American Physical Society (APS), with Theodore Hodapp and Monica Plisch as the APS leaders. Their partnership, we believed, could demonstrate on-the-ground to disciplinary faculty—that it was permissible, and in fact laudable, for university faculty to directly address the needs of science teacher preparation. We joined together with APS because of its demonstrated leadership in addressing how to overcome barriers in institutions of higher education to promote institutional change through the PhysTEC program.

The American Physical Society has practiced ground-breaking leadership in opening up a major disciplinary society to disciplinary-based education research and practice. The Society has built paths within the discipline that legitimize and respect the study and practice of physics education research and practice at the undergraduate level, and especially for the preparation of future physics high-school and middle-school teachers. We at APLU were keen to learn how such a prestigious scientific society had been able to move the dial on the culture of physics to embrace disciplinary-based education research and the preparation of physics teachers. With the concurrence of the National Science Foundation, we used a very small allocation from within the MSP-RETA grant to support APS’s documentation of how this remarkable change occurred.

The American Physical Society “just did it”—albeit with guts, determination, and creative leadership—setting a model for other disciplinary societies. Only through partnership between the disciplinary departments in U.S. colleges, universities and education units can we make progress in improving both the numbers and quality of preparation of future physics teachers, and other science and mathematics teachers. We believe that this brief paper provides important insight into this process of change within a major disciplinary society and higher education institutions, and we encourage other disciplinary societies to follow APS’s lead.



# History of APS Involvement in Education

## Introduction

Is the improvement of education at the undergraduate level—and even at the high-school level—an essential goal of a major scientific society? In the past, the typical answer to that question was probably a dismissive “no.” But in recent years, the American Physical Society (APS)<sup>1</sup> has embraced education as an integral part of its mission, and has developed numerous projects and programs to improve science education at all levels. Today there is a firm consensus that, as APS Executive Officer Kate Kirby puts it, “education is absolutely central to who we are as a community.”

Although APS has had a Committee on Education continuously since 1973, it was not until 1986 that the Society appointed an education officer. Since then, educational staffing and activities have multiplied several times over. APS now employs both a director and an associate director of education, and operates more than a dozen ongoing education projects supported by numerous external grants and millions of dollars in private contributions. These projects have been both highly successful and widely recognized, and are beginning to be emulated in other disciplines. The New Faculty Workshops, a signature education initiative, co-sponsored by APS, has been cited in a major report<sup>2</sup> released by the President’s Council of Advisors on Science and Technology (PCAST). In addition, APS’s flagship Physics Teacher Education Coalition (PhysTEC) project has inspired the American Chemical Society to launch a substantial counterpart effort in high school chemistry teacher education.<sup>3</sup>

The story of how APS reached this leadership position in education, over decades of intense self-examination and occasionally heated debate, is the story of how an organization, responding to its membership, has taken responsibility for issues that affect not only members themselves, but also the nation’s teachers, students, and citizens.

## APS’s Early Involvement in Education

Early in its history, APS focused on promoting physics research, publishing journals, and organizing meetings, and generally declined to address educational and pedagogical issues except in marginal fashion. In 1915, the Society did appoint a committee “to consider ‘how the Society can be made useful to teachers in colleges and secondary schools,’”<sup>4</sup> and an APS representative, Homer L. Dodge, was appointed to present results of physics research to the editorial board of *School Science and Mathematics*, which was at the time an important journal for physics teachers.

In 1920, APS established an “Educational Committee” to create a plan “whereby the Society can give adequate consideration to the teaching of physics.”<sup>5</sup> That committee released several reports, such as “The Teaching of Physics with Especial Reference to the Teaching of Physics to Students of Engineering.” But advocates of APS involvement in education issues still felt the Society was not taking a sufficiently active role; as a result, in 1930 they formed a separate organization, the American Association of Physics Teachers (AAPT), with Dodge as president.

It was not until 1973 that APS again formed a Committee on Education, largely in response to a changing cultural climate that encouraged more active social engagement by institutions of all kinds. The late 1960s and early 1970s were a time of upheaval for American society, as the growing civil rights, women’s rights, and environmental movements forced many organizations to re-evaluate their roles. APS members’ involvement in movements against the Vietnam War and the US military-industrial complex challenged the Society to become more involved in issues that extended beyond its traditional purview. For example, APS came to the aid of “refusenik” physicists denied exit from the Soviet Union in the 1970s and 1980s. At the same time, there were reports of a looming “jobs crisis,” as the production of physics PhDs was outpacing the availability of appropriate academic positions; this led APS to strengthen its career programs for members.

In this milieu, the Society formed not only the Committee on Education (COE), but also a Committee on Minorities (COM), a Committee on the Status of Women in Physics (CSWP), a Committee on International Freedom of Scientists, and the Forum on Physics and Society. At the time, those groups consisted of and were run by concerned APS members, and generally operated without direct Society involvement.

## APS Creates Department of Education and Outreach

The awareness of educational problems facing the nation increased significantly in the 1980s. In 1983, President Reagan's National Commission on Excellence in Education published a landmark report, *A Nation at Risk: The Imperative for Educational Reform*<sup>6</sup>, which warned against "a rising tide of mediocrity that threatens our very future as a Nation and a people." A country that had grown accustomed to regarding itself as an educational leader began to think critically about addressing lackluster performance in many of its schools.

In 1986, physicist and administrator Kenneth Ford was appointed APS's first Education Officer, chiefly emphasizing graduate education issues. Ford soon left to become Executive Director of the American Institute of Physics (AIP), the "umbrella organization" that counts APS and nine other professional societies as members. He was succeeded by the "dynamic and creative"<sup>7</sup> Brian Schwartz, a physicist and administrator at Brooklyn College in New York, who had earlier been active in the formation of the APS Forum on Physics and Society.

Desiring to act on concerns raised in the *Risk* report, Schwartz focused substantial energy on forging collaborations between university physics professors and high school physics teachers. In 1987, APS began building "local physics alliances" around the country, based on a model developed in the 1970s and early 1980s by, among others, Judy Franz, then a physics professor at West Virginia University and later APS Executive Officer.<sup>8</sup> These alliances brought together college faculty and high school physics teachers for two-day meetings, usually at a university. Faculty shared their expertise on current physics research, while K-12 teachers provided insights on pedagogical approaches. At the conclusion of each meeting, participants were required to produce a set of "next steps" designed to ensure continuation of the collaboration. According to Schwartz, between 20 and 30 alliances were formed, some of which continue to function today. The alliance project was funded by a \$178,000 grant from the National Science Foundation (NSF)—the first time APS had brought in external funding for an education-related initiative.

Schwartz also began efforts to update and reform the introductory physics curriculum in US undergraduate programs. Despite the early 20<sup>th</sup>-century revolutions of quantum physics and relativity, nearly every physics department in the country was still introducing the subject with a year of 19<sup>th</sup>-century (or earlier) classical physics. APS partnered with AAPT and AIP in this initiative, which resulted in several new textbooks that began with modern physics, and at least one conference. This effort also introduced a model of APS-AAPT-AIP collaboration on education issues that would be repeated productively in the future.

An additional effort to reform upper-level laboratory experience met with significant success, and many undergraduate programs now include modern physics labs. Schwartz credits this effort with inspiring Carl Wieman (winner of the 2001 Nobel Prize in Physics) to take a leadership role; Wieman has been perhaps the nation's most prominent advocate for physics education reform. Schwartz also created APS's High School Physics Teachers Days, during which high school and middle school physics and physical science teachers are invited to APS meetings for one-day professional development programs. Teachers Days typically include workshops featuring new classroom materials, lectures on contemporary physics topics, and opportunities for K-12 teachers to meet working physicists.

In order to administer the growing number of programs, in the early '90s APS hired a program administrator and created a Department of Education and Outreach, which also oversaw programs to increase the diversity of the physics community. (This unit evolved into today's Department of Education and Diversity.) Diversity programs at the time included scholarships for minority undergraduate physics students, building and maintaining rosters of women and minority physicists, and a biannual newsletter published by CSWP. All of these programs continue today with APS staff support.

In 1990, APS created the Forum on Education (FEEd), providing a new way for members to engage in education issues. (An APS forum is a membership group devoted to a particular issue.) In creating this forum, the Society had to carefully delineate the separate roles of the FEEd and the existing Committee on Education, and also to address members' concerns that the forum might appear to overlap with AAPT activities. (Many education-minded APS members are also members of AAPT.) Those problems have been avoided, says Judy Franz, by continual close communication and coordination between the two societies. For example, FEEd bylaws require that a minimum of three members of its executive committee be AAPT members, and also provide for a non-voting AAPT-appointed representative. The FEEd now has over 4,700 members, nearly 10% of APS's total membership, and is one of the Society's largest units.

## Leadership in Education: The First Campaign

In 1993, APS moved from New York to College Park, Maryland, where it joined AIP, AAPT, and the American Association of Physicists in Medicine in one building, the American Center for Physics. At the same time, Judy Franz became APS's Executive Officer. Franz had deep experience with and commitment to physics education, having previously served as chair of the COE and as president of AAPT. She came to APS with an explicit mission to develop partnerships with AAPT and expand APS's educational activities. One of her first actions was to hire Ramon Lopez, a space physicist at the University of Maryland, as Education Officer.

Building on Schwartz's physics alliances, Lopez created the Teacher-Scientist Alliance Institute (TSAI), a major effort designed to reform science teaching at the elementary level in school districts around the country. The TSAI led a number of workshops and institutes in which university physicists could work directly with school districts that were already pursuing, or in the position to begin, systemic science education reform based on national education standards. The project gained recognition from the National Academy of Sciences for involving scientists and engineers in K-12 education.<sup>9</sup> As with the earlier physics alliances, the project's impact was widespread: eventually, 54 school districts or consortia of school districts in 20 states were involved.<sup>10</sup> A number of these alliances continue in some form to this day, though without ongoing APS support.

The launch of the TSAI was funded primarily by the Campaign for Physics, a large-scale fundraising effort undertaken jointly by APS and AAPT that brought in approximately \$5 million from corporate, foundation, and individual donors. The Campaign mobilized 39 Nobel laureates as well as numerous industrial leaders to make appeals to donors. The campaign's exploratory committee had found that education projects were at the top of potential donors' priority lists, and this finding led to a significant expansion of APS education initiatives, as well as increased APS-AAPT collaboration. In addition to the TSAI, the Campaign funded the AAPT-led Physical Science Resource Center (PSRC), a collection of high-quality physics and physical science curricular materials available at no cost to schools; the Physics Teacher Resource Agents, an AAPT program to engage experienced physics teachers as mentors for beginning teachers; and the APS Minority Scholarship Program mentioned above.<sup>11</sup>

Beyond these projects, APS expanded its educational reach in a number of directions, often in conjunction with AAPT. A series of New Faculty Workshops was launched in 1995 to provide professional development in teaching to early-career physics and astronomy faculty. Although the workshops focus mainly on introducing participants to interactive teaching methods for their introductory courses, they also incorporate topics such as improving diversity and time management. These workshops now reach more than 40% of all new physics and astronomy faculty. "The early workshops were focused on faculty from research-intensive universities," reports Duncan McBride, the project's NSF Program Officer, "but subsequently expanded to include faculty from all types of institutions."

Throughout the New Faculty Workshops' history, AAPT, APS, and more recently the American Astronomical Society (AAS) have worked in partnership to provide this highly regarded program to the nation's undergraduate physics educators. The workshops were recently recognized by PCAST<sup>2</sup> as an example of how education research results and developments can be widely understood and adopted by faculty.

The PSRC expanded into an online digital library named ComPADRE, a collaborative effort by APS, AAPT, AIP, and AAS that now includes over a dozen "collections" of digital educational materials for audiences including high school and university physics students and teachers, faculty seeking to prepare physics teachers, and informal physics learners. APS has devoted staff time to building and maintaining several of these collections.

As these new projects were getting started, education was also finding its way into many of APS's traditional activities. Franz was a strong advocate of incorporating education topics into publications and meetings, and results were soon visible in *APS News* (APS's monthly publication for members), APS meetings, and *Physics Today* (a monthly magazine published by AIP and sent to all APS members). In addition, Franz urged that biennial department chairs conferences, which are organized jointly by APS and AAPT, have themes related to education. The 1995 conference was organized around graduate education, and contributed to a growing recognition of the need to provide relevant preparation for the many physics PhD recipients not heading toward academic positions.

The 1997 topic was undergraduate physics education, which was then in a period of crisis. Over the course of the 1990s, the number of physics majors graduating from colleges and universities in the US decreased dramatically, from around 4,300 to around 3,300 per year, and some departments were threatened with closure. The 1997 conference prompted APS to hold a one-time Strategic Planning Institute for Improving Undergraduate Physics Education. A few years later,

a national task force sponsored by APS, AAPT, AIP, and the ExxonMobil Foundation visited 21 physics departments that had been able to maintain thriving programs and large numbers of graduates during the 1990s, while most programs floundered. In 2003, the task force produced a report titled Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP), which remains the seminal text for departments seeking to improve their programs and recruit and retain majors. The SPIN-UP report is featured on APS and AAPT websites,<sup>12</sup> and played a role in reversing the declines in physics graduates over the next decade.

## The PhysTEC Era Begins

In 1999, Franz, Bernie Khoury (AAPT Executive Officer), and Jim Stith (AIP Education Officer) began planning a joint project to help physics faculty prepare high school teachers. It had become clear that there was a severe shortage of qualified physics teachers in American schools: only about one-third of high school physics teachers held physics degrees, and school principals reported that physics teaching posts were among the hardest to fill.<sup>13</sup> According to Franz, there was a strong sense among these three societies' leaders that they had a responsibility to engage their members on this issue.

APS was seen as the natural leader because of its strong ties to physics departments and faculty around the country. To lead this new project, Franz hired Fred Stein as APS's new Education Director. Stein had started a project at Colorado State University called the Rocky Mountain Teacher Education Coalition, through which university science departments took an active role in teacher education. He became the first education director to officially work full-time at APS, where his main task was to replicate his success in Colorado at the national level. The new project was called the Physics Teacher Education Coalition, or PhysTEC.

PhysTEC would become a multi-site, multi-year project unprecedented for APS in its scope. It started with \$100,000 planning grants from NSF and the US Department of Education, and in 2001 was awarded a \$5.76 million NSF grant that funded PhysTEC sites at six selected universities. Each initial site hired master high-school teachers to work within physics departments as "Teachers-in-Residence," and to develop a suite of teacher recruitment, education, and mentoring activities. Project leadership, consisting of a team of APS, AIP, and AAPT staff members, provided centralized resources and organized annual meetings for site leaders. Significantly, none of the NSF funding went to Stein's salary, demonstrating APS's significant financial commitment to the project.

From the beginning, PhysTEC leaders intended to build a broad coalition of universities and colleges engaged in physics teacher education, and to foster institutional change. Project leaders hoped to get physics and education departments working together to create high-quality, coherent, sustainable programs. Not surprisingly though, the project encountered significant inertia. Physics and education faculty at the same university rarely interact professionally—they typically work in different buildings, belong to different administrative units, go to different conferences, and read different journals. Physicists encouraging students to become teachers often found that their education schools required a year or more of additional coursework for certification—a significant financial burden for students pursuing a career unlikely to be very lucrative. However, by engaging education faculty as colleagues, and delivering highly qualified physics graduates excited about teaching, PhysTEC site leaders have developed successful collaborations that have led to better integrated and less burdensome degree programs.

PhysTEC leaders also sometimes found that their scientist colleagues lacked enthusiasm for taking on teacher education activities. Physics departments—like university science departments generally—have traditionally focused on research and teaching, and have rarely viewed teacher education as their responsibility. As Laurie McNeil, physics professor and PhysTEC project leader at the University of North Carolina at Chapel Hill, put it,

The shortage of good high school science teachers is a problem all science faculty members... are well aware of, and everyone thinks it would be great if *someone* were to solve the problem. They don't necessarily want to do it themselves... and they certainly don't want the solution to come at the expense of their research and upper-division teaching, but they are happy to reap the benefits.<sup>14</sup>

McNeil, along with colleagues in the biology department, was instrumental in creating a program at UNC-CH that enabled physics and biology majors to get teacher certification (prior to this program, UNC-CH had no high school teacher certification program). However, she encountered substantial resistance when trying to get the university's other science departments involved—until their students started asking why the program wasn't available to them, too. Now the program extends to chemistry, geological sciences, and math—although some departments such as chemistry are "still not deeply invested," says McNeil.



PhysTEC leadership has sought to minimize institutional inertia and opposition by requiring that sites seeking funding show engagement from both physics and education faculty, as well as higher-level administration. For example, sites in the first round of funding were required to demonstrate support from the physics department chair plus at least two faculty members. As the project has matured, PhysTEC leadership has increasingly advocated that such support include financial commitments from universities to sustain the program after external funding ends.

## Physics Education Research Becomes Part of the APS Mission

Concurrent with the expansion of programs to improve physics education within colleges, universities, and K-12 institutions, the past two decades have seen major developments in our understanding of how students learn physics. Starting in the 1990s, APS leadership and staff undertook active support for the developing field of physics education research (PER). PER, which includes theoretical and experimental research on the teaching and learning of physics, had emerged in the 1990s as an academically respectable endeavor, and a number of research groups dedicated to PER had formed at universities around the country.

In 1999, the APS Council (the governing body of APS) adopted a policy statement that PER as a sub-discipline of physics should be considered by the same criteria of scholarship as other areas of physics research—publication in peer-reviewed journals, presentation at professional conferences, etc. In the policy statement, APS said that it “applauds and supports the acceptance in physics departments of research in physics education,” and “recognizes that the success and usefulness of physics education research is greatly enhanced by its presence in the physics department.”<sup>15</sup> Noah Finkelstein, a physics professor and education researcher at the University of Colorado, attests to the importance of APS support for PER: “With the backing of APS, physics has become the acknowledged leader in discipline-based educational research aimed at improving undergraduate education.”

By far the most significant step APS took to support the development of PER, however, was the creation in 2005 of *Physical Review Special Topics: Physics Education Research (PRST-PER)*, a journal devoted to research in physics education. By that time, there was a small explosion in new PER groups around the country, and these groups were training graduate students, but there were few opportunities for researchers to publish their work. To respond to what founding editor Robert Beichner described as “pent-up demand for a publication venue in the PER field,” then-APS Editor-in-Chief Martin Blume agreed to add an education research journal to the *Physical Review* family of journals. Blume notes that while there was general support within the physics community and Society leadership for starting the journal, the presence of a highly motivated founding editor was crucial to success.

Since its founding, *PRST-PER* has established itself as a significant and valued publication. Interest in PER has continued to grow, and the journal’s article views increased by nearly 50% between 2008 and 2010. It now has an “impact factor” over two, meaning that the average article in the journal is cited by more than two other published articles (impact factors greater than one are considered a sign of journal significance). Rutgers University professor Eugenia Etkina has testified to the importance of having a targeted and respected venue for disseminating her results: “If it were not for this journal, many people would have had zero opportunity to publish their research. My professional life has become incredibly easier and ten times more productive since *PRST-PER* began.”

As an online-only, open-access journal, *PRST-PER* was made available for free on the APS website, thus avoiding some of the overhead associated with a traditional printed journal; however, costs are still involved in editing articles, managing peer review, journal composition, and online hosting. About half of *PRST-PER*’s expenses are paid by authors or their institutions, while the other half is borne by APS. To date, APS has contributed nearly \$300,000 to *PRST-PER*.

In addition, APS meetings now routinely include sessions devoted to PER, mostly sponsored by the FED. For example, the 2012 March Meeting—APS’s largest annual meeting—featured a session on “Physics Education Research and Resources,” with talks on topics such as the use of technology in classrooms and students’ mental models of physics concepts. “If we want physics faculty to change the way they teach, it’s crucial to have PER at venues where it can reach a broad swath of the physics community,” says Theodore Hodapp, current Director of Education and Diversity at APS. “It can’t just be education researchers talking to each other.”

## APS Becomes a Recognized Education Leader

Hodapp has led the Education and Diversity Department into its most productive period to date. An atomic physicist on leave from Hamline University in Minnesota, he joined the Society in 2004, following a stint as a program officer at NSF. Franz notes that Hodapp was not only her top choice to succeed the retiring Fred Stein, but also the preferred

candidate of APS's collaborators at AAPT and AIP. Hodapp was well known within the physics education community, and his ability to work effectively with collaborators at a wide range of organizations has had a substantial effect on advancing PhysTEC and APS's other educational initiatives.

One of Hodapp's first priorities within PhysTEC was to build a broader coalition of engaged institutions—a stated goal of the project, although one that had until that time undergone little growth. Hodapp expanded the annual PhysTEC meeting from a small gathering for funded sites to a full-fledged conference for physics teacher educators. Meanwhile, the coalition has grown to around 260 members, representing more than one-third of the physics degree-granting departments in the US.

In 2006, APS launched the 21st Century Campaign, with the goal of raising \$3.5 million for education, diversity, and outreach activities. The campaign surpassed that goal by \$800,000 by the end of 2008. PhysTEC was the primary beneficiary, and was able to add four new APS-funded sites in 2007.<sup>16</sup> As a result of the campaign's success, as well as the continued priority placed on PhysTEC within APS, the Society created the position of Assistant Director of Education. It was filled by Monica Plisch, former director of Cornell University's Institute for Physics Teachers. Plisch's presence allowed PhysTEC to expand in new directions, including \$900,000 in grants from NSF's Robert Noyce Teacher Scholarship Program, which have provided scholarships to future teachers at PhysTEC sites.

By the end of the first major award period, PhysTEC had received more than \$10 million from federal sources, the APS Capital Campaign, and contributions from each of the universities involved. In 2009, APS received an additional \$6.5 million award from NSF to support a substantial continuation of the project's work. As a result, the project has added four or five new sites every year since 2010, and expects to fund a total of at least six more sites in addition to the 29 that have already received support. In addition, PhysTEC has launched several publication efforts to benefit the entire community. The first of these—*Teacher Education in Physics*—is a bound compilation of research articles on physics teacher education, and was published in late 2011. The second major effort is a report published in 2012 by the National Task Force on Teacher Preparation; PhysTEC established the task force and contributed to the production of the report.

PhysTEC has also formed partnerships with numerous national organizations that have recognized the project as a model of teacher preparation. For example, a long-standing partnership with UTeach, a science and mathematics teacher preparation program founded at the University of Texas at Austin, led to a joint conference in 2011, and to the incorporation of elements of PhysTEC at a number of UTeach replication sites (and vice versa).

PhysTEC leadership is also working with the Association of Public and Land-grant Universities on APLU's Science and Mathematics Teacher Imperative, which has secured pledges from 99 universities and 13 university systems to increase the numbers of science and math teachers graduating from their campuses. Moreover, the American Chemical Society is now starting a Chemistry Teacher Education Coalition (CTEC), modeled in large part on PhysTEC, with members of APS's Education and Diversity department sitting on CTEC's advisory board. In addition, a regional effort is taking shape in the California State University system, where administrators are interested in replicating PhysTEC at a number of their campuses (four Cal State campuses are already PhysTEC sites).

## Current Activities and Future Directions

The number of APS education initiatives continues to grow. Recent and ongoing projects and products include

- Conferences on improving graduate physics education, building thriving undergraduate physics programs, and increasing minority participation in graduate physics education
- A convocation of site leaders of Research Experience for Undergraduate programs
- A campaign to use marketing techniques to increase the numbers of undergraduate and high school students taking physics
- A training manual for physics research mentors
- Materials for teaching a seminar on research ethics education
- A series of curriculum units designed for high school teachers, accompanied by kits of classroom materials
- An online database of PER speakers
- Awards to groups for excellence in physics education, and to departments that have improved undergraduate programs

- A project to pair high school teachers unfamiliar with physics with physicists to provide professional development and support
- A planned workshop to engage veteran physics faculty in education reform, in a format similar to the New Faculty Workshops
- PhysicsQuest, which designs an activity kit annually for middle school classrooms
- A series of webinars on physics education and career topics

For the past few years, APS has also been developing a diversity project on a similar scale to PhysTEC—the APS Bridge Program (APS-BP). The immediate goal of the APS-BP is to increase the number of underrepresented minority students receiving graduate degrees in physics, but the ultimate outcome will be improved graduate education in physics for all students. APS education leaders are also working to integrate diversity more closely into all education projects. For instance, a significant number of recent PhysTEC grants have gone to minority serving institutions (MSIs), and the project has held workshops specifically to help MSIs submit competitive proposals in future rounds. A number of APS’s career-related initiatives, such as student travel grants to APS meetings, also have the potential to improve the overall educational experiences that students receive.

The education and diversity efforts described in this article cannot succeed without highly motivated people. As Judy Franz put it, “to make change in anything you need someone with a lot of energy,” and it is the energy of dedicated APS staff and members that has driven the Society’s transformation. That said, the acceptance of education research and increased emphasis on education activities within the academic physics community has been a long-term process that continues to evolve. Many academic departments and individual physicists have not fully embraced the new commitment—some for practical reasons, some for more ideological ones. Ultimately, though, APS leadership expects that the success of the Society’s projects, as well as the results from well-founded research on teaching and learning, will continue to provide compelling reasons for increasing numbers of physicists to become engaged in the education revolution.

The transformation described above has required nothing less than a wholesale, and occasionally contentious, reexamination of the roles and responsibilities of a scientific society. It has demanded that APS expand its activities, priorities, and investments from a relatively narrow focus on promoting research and its members’ careers to a much broader mission: ensuring the future quality and welfare of the entire discipline of physics through a commitment to education, and thereby increasing its potential for ongoing contributions to society and human progress.

The story of this transformation may serve as a model to organizations as they reconsider their roles and obligations within the broader world in which they reside.

## Acknowledgements

We thank Robert Beichner, Martin Blume, Eugenia Etkina, Noah Finkelstein, Judy Franz, Theodore Hodapp, Kate Kirby, Ramon Lopez, Duncan McBride, Laurie McNeil, Brian Schwartz, Gay Stewart, and Helen Quinn, for providing their perspectives on the issues discussed in this article. Finally, we would like to give special thanks to Curt Suplee for his editorial oversight of the project.

## Methodology

The information in this article was gathered from written sources and in-person interviews. The principal written source for historical information is past APS treasurer Harry Lustig’s 2000 *American Journal of Physics* article “To advance and diffuse the knowledge of physics: An account of the one-hundred-year history of the American Physical Society.” Other sources include *APS News*, APS Forum on Education newsletters, and the APS website. Interviews were conducted with the people named in the acknowledgements.

## Appendix: APS Background

The American Physical Society (APS) is the United States' leading professional organization for physicists, and the second largest such organization in the world. APS held its first meeting at Columbia University with 36 physicists in attendance; today, its annual March Meeting draws nearly 10,000 physicists and is the largest regular gathering of physicists in the world. Since 1913, APS has published the *Physical Review*, which has since expanded into five separate sub-journals (*Physical Review A* through *E*), two online-only special topics journals, and a new open-access journal *Physical Review X*. In addition, APS publishes the *Review of Modern Physics*, *Physical Review Letters*, and synopses of technical articles in the online journal *Physics*. APS journals collectively publish over 19,000 articles per year.

Organizing meetings and publishing journals continue to be two of APS's main activities. However, the scope of the organization's activities has expanded greatly in recent decades, and now includes a large variety of education, diversity, career, outreach, and international programs; media relations and publication of *APS News*, a monthly newspaper sent to all members; and various member services and benefits.

APS's website is [www.aps.org](http://www.aps.org).

## References

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### **About APLU**

The Association of Public and Land-grant Universities (A·P·L·U) is a research and advocacy organization of public research universities, land-grant institutions, and state university systems with member campuses in all 50 states, U.S. territories, and the District of Columbia. The association is governed by a Chair and a Board of Directors elected from the member universities and university systems. President Peter McPherson directs a staff of about 45 at the national office in Washington, D.C.

### **About APS**

The American Physical Society ([www.aps.org](http://www.aps.org)) is a non-profit membership organization working to advance and diffuse the knowledge of physics through its outstanding research journals, scientific meetings, and education, diversity outreach, advocacy, and international activities. APS represents over 50,000 members, including physicists in academia, national laboratories, and industry in the United States and throughout the world. Society offices are located in College Park, MD (Headquarters), Ridge, NY, and Washington, DC.

### **About PhysTEC**

The mission of the Physics Teacher Education Coalition (PhysTEC) project is to improve and promote the education of future physics and physical science teachers. The project has built a coalition that includes a large fraction of all physics degree-granting institutions, and has supported a number of these institutions with multi-year grants to build model physics teacher education programs. PhysTEC recognizes and seeks to address areas of especially high need for physics and physical science teachers, including nationwide shortages of underrepresented minority teachers, as well as severe shortages of teachers in certain geographic areas. The project is a partnership between the American Physical Society (APS) and the American Association of Physics Teachers, and is supported by the National Science Foundation, as well as individual and corporate contributions to APS.

### **About SMTI**

This project is a component of A·P·L·U's Science and Mathematics Teacher Imperative (SMTI), a consortium of 132 of A·P·L·U's public research universities, and 13 university systems that is working to transform middle and high school science, technology, engineering, and mathematics (STEM) education by preparing a new generation of world-class science and mathematics teachers. Collectively, SMTI members prepare more than 8,000 science and mathematics teachers annually – making it the largest STEM new teacher initiative in the country.