Aspiring to Lead

Engaging K-12 teachers as agents of national change in physics education.

A report from the AAPT Physics Master Teacher Leader Taskforce

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The following acronyms designate Task Force members' various accolades, including:

AEF: *Albert Einstein Distinguished Educator Fellow*
NBCT: *National Board Certified Teacher*
PAEMST: *Presidential Awardee for Excellence in Math and Science Teaching*
PTRA: *Physics Teaching Resource Agent*

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Executive Summary

Aspiring to Lead: Engaging K-12 teachers as agents of national change in physics education

The nation has an urgent need for highly qualified K-12 STEM educators. This need is particularly evident in the field of physics teaching. Despite significant efforts to recruit, prepare, and retain highly qualified physics teachers through existing programs, the severe deficit of highly qualified teachers at the secondary level remains (PhysTEC, 2016). In schools where physics is offered, fewer than half of all physics teachers have a degree in physics or physics education (White & Tyler, 2015). Even more pressing is the significant challenge in elementary education. Elementary school educators have little to no training or support in teaching physics concepts at all. Only 5% of elementary educators have a degree in science, engineering, or science education, and elementary teachers report that science is the area in which they feel least prepared to teach. Notably, of the 39% of elementary teachers who do feel prepared to teach science, only 17% and 4% feel prepared to teach physical science and engineering, respectively (Trygstad, 2013).

The reasons behind the lack of qualified teachers in physics education, especially at the secondary level, are highly complex, but the perceptions of physics as a difficult subject to learn and of teaching as an underpaid, unattractive career choice for many physics majors are significant factors that influence decisions to pursue teaching as a career (Marder, 2017). When novice teachers do enter the profession, especially teachers of physics, they are often confronted with isolation and a lack of support. Unfortunately, this disconnectedness changes little over time, as 80% of all high school physics teachers teach in isolation in their schools (Tesfaye & White, 2012). Even experienced teachers who have the capacity and desire to make change through their leadership find little opportunity to do so (NRC, 2014), be it in improving the instructional practices of others, contributing to supportive professional networks, or influencing policy that impacts teachers and physics education.

The status of K-12 physics education is a significant issue in preparing today's students for the workforce of tomorrow. It carries with it implications for the nation's economic stability, security, and social welfare. Physics, in particular, often serves as a foundation for many STEM careers, most notably in the fields of engineering, the health professions, and computer science. From kindergarten through secondary education, teachers frequently provide the foundation of students' experiences with physics specifically and STEM more broadly.

The major thesis of this report is that the development and implementation of programs to address these issues in K-12 education should be carried out by teachers, for teachers. Although the nation has begun to recognize the essential role of teacher leaders as advocates for systemic change (Teacher Leader Model Standards, 2016; National Education Association, 2016), the focus has recently shifted to the untapped potential of STEM teachers. The recognition of the importance of STEM teachers to the nation's future, especially with respect to the future STEM workforce, was strongly emphasized under the Obama administration by the President's Council of Advisors on Science and Technology. In their 2010 *Prepare and Inspire* report, they stated that it is essential that teachers' voices "*drive progress and aspiration in the profession*." Specifically, the report called for the nation to:

> *"envision a more enhanced, sustained role for teachers, for example, through a national network of teachers that can serve as mentors, leaders in their schools, and liaisons to public officials, or as excellent teachers who would be connected with their peers to share best practices and materials, or to provide a voice for their profession in educational policy and to be effective advocates for STEM in their schools, school districts, and communities."* (President's Council of Advisors for Science and Technology, 2010, 12 & 69).

Despite the attention drawn to this effort through President Obama (White House, 2012), the National Science Foundation (NSF, 2015), the Every Student Succeeds Act (S. 1177, 2016, Sec. 2245), and the Department of Education's Building STEM Teacher Leadership initiative (U.S. Dept. of Ed., 2016), no such nationwide network of STEM master teachers yet exists.

This report, authored by 17 K-12 teachers of physics, is meant to provide guidance to the American Association of Physics Teachers (AAPT), its collaborators, and those vested in physics education, in how to support physics teachers as leaders and as agents of change for physics education. It presents a framework for physics teacher leadership, identifies the underlying principles behind successful programs that build leadership capacity, and sets forth three priority areas for future program development to build new and sustain existing leaders. These efforts are founded upon both the mission of the AAPT and its members' involvement in teacher leadership through a variety of professional development and leadership (PD&L) programs, some of which are detailed in section 2 of this report. Additionally, it complements the efforts of a number of states that have already enacted teacher leadership programs at the state level.

Physics Master Teacher Leadership

Recognizing the need for networked physics teacher leadership, the AAPT has taken up the task of creating new opportunities for teachers of physics to be agents of change for education through their leadership at a national level. To solve the challenge to provide professional development to the nation's 28,000+ high school and 3M+ K-8 teachers of physics, the emphasis of PD&L must begin with *leadership.* By first building a core group of teacher leaders, the AAPT can then build more robust, coherent professional development opportunities for a wider population of physics educators.

The work of the AAPT on this set of issues began in July 2016 through the identification of a set of core Physics Master Teacher Leaders (PMTLs)—teachers who already had demonstrated their excellence as leaders as Presidential Awardees for Excellence in Math and Science Teaching, AAPT Physics Teaching Resource Agents, PhysTEC Teacher Educators/Teachers-in-Residence, National Board Certified Teachers, AMTA Workshop Leaders, Albert Einstein Distinguished Educator Fellows, Noyce Fellows, Knowles Fellows, Kenan Fellows, and leaders of various local, state, and national organizations. These PMTLs constituted a task force with the goal to "*create a new set of aspirational and coherent professional development and leadership (PD&L) models for the K-12 physics education community*."

A Framework for Physics Teacher Leadership

In an effort to more clearly define what teacher leadership looks like in the physics teaching profession, the PMTLs developed a physics teacher leadership framework. PMTLs discussed their own leadership journeys and the essential elements they all experienced in order to become agents of change. All of these teacher leaders have been recognized for their excellence by the AAPT, other national professional societies, federal agencies, and even presidents of the United States. From July to November 2016, these individuals met virtually to discuss their visions for teacher leadership in the context of physics, as well as the interplay between teacher leaders and novice teachers with the potential for leadership. What resulted was a framework that can be used to track both one's personal growth as a leader as well as to assess and evaluate programs that are intended to help teachers enhance their own leadership. Dimensions of this leadership framework developed by the PMTLs include the following:

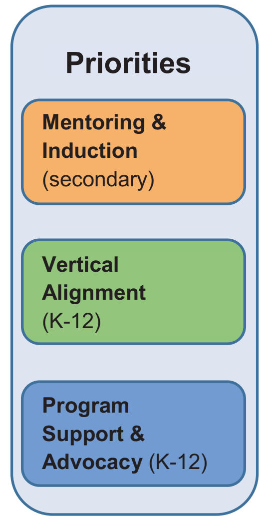
- ***Experience:*** (1) Emerging – teachers who are at the beginning stages of their leadership, or (2) Transforming – teachers who are already leaders with significant impact. These two groups of teachers have different wants and needs.
- ***Sphere:*** (1) Instructional – supporting other teachers with their classroom instruction, (2) Association – supporting other teachers through professional networks, or (3) Policy – supporting teacher influence on educational policy and its implementation.
- ***Location:*** (1) Local – school or district-level, (2) State, or (3) National – teacher leadership can occur at all of these levels.
- ***Interactions*** among emerging and transforming teacher leaders – teacher leadership naturally implies that existing leaders are helping to develop the new generation of leaders, and that emerging and transforming leaders share a mutually beneficial relationship when interacting with each other.

Principles, Priorities, and Programs

> **Principle:** PD&L programs must build strong **Networks & Community.**

Using the framework as a conceptual foundation, the PMTLs then met face-to-face at the American Association of Physics Teachers headquarters in December 2016. The teachers defined (1) principles: underlying essential elements of teacher leadership, (2) priorities: the most important spheres of activity and influence for teacher leadership, and (3) recommended programs: specific approaches for engaging novice and experienced teacher leaders that they believe should strategically orient the AAPT and its collaborators in their work in the physics education community. With **Network and Community-Building** as the underlying principle for all of AAPT's work, the Task Force identified the following K-12 PD&L priorities for the physics education community:

- ***Mentoring and Induction*** of secondary physics teachers,
- ***Vertical Alignment*** of education efforts to build leadership capacity across the K-12 spectrum of physics educators, and
- ***Program Support and Advocacy*** to ensure the sustainability of programs through teacher leaders and to provide leadership opportunities to existing transforming teacher leaders who are ready to lead others.

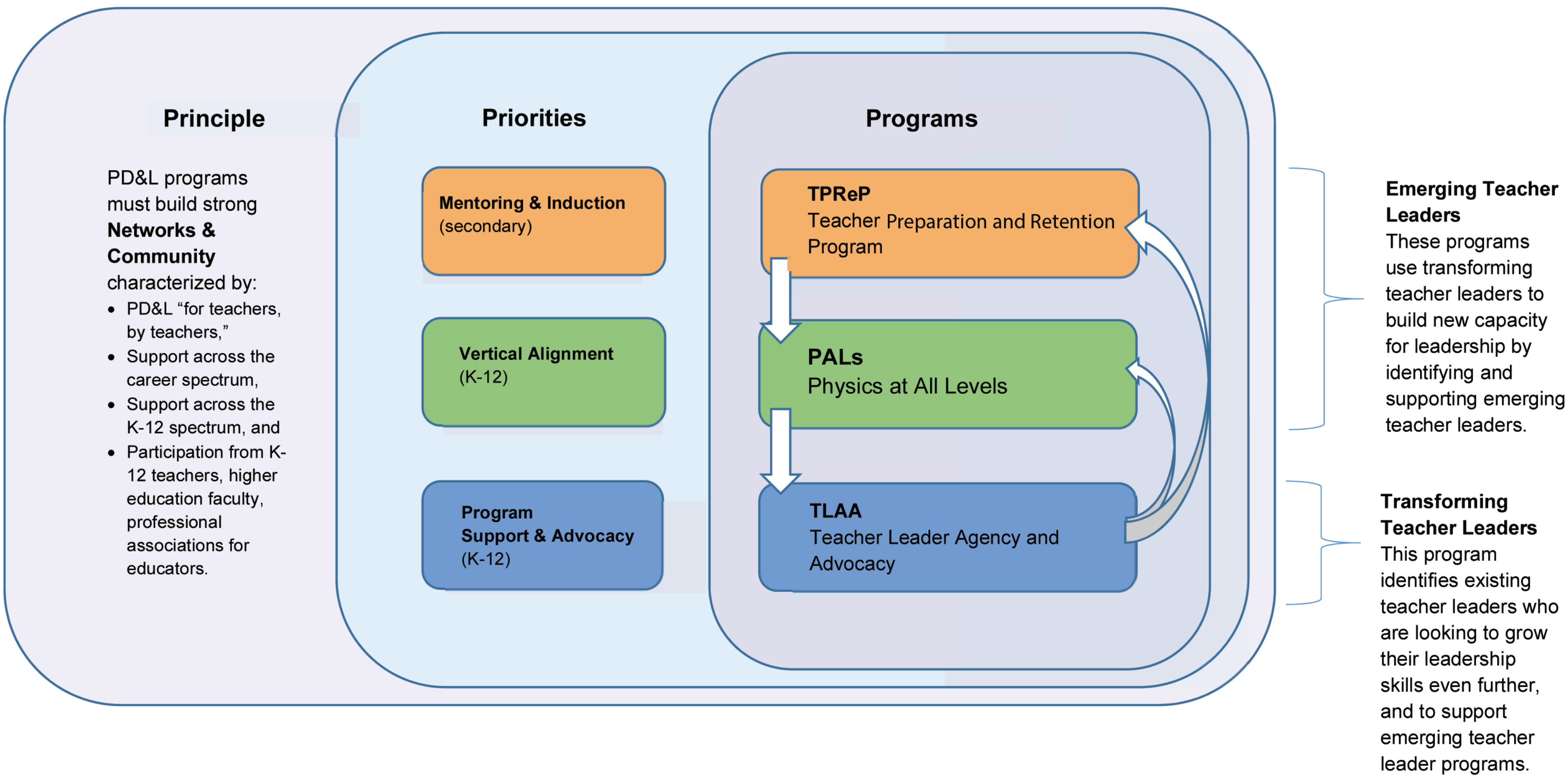


Recommendations

The Task Force suggests the development of three specific programs within AAPT, aligned with the principle of networking and community building in each of the priority areas. Specifically, the Task Force recommends that AAPT develop the following types of programs:

1. A multi-year program to support *novice secondary physics teachers,*
2. A tiered leadership program to support *interdisciplinary teams of primary and secondary physics educators with high potential for leadership* aimed at providing support for local teacher cohorts,
3. A STEM advocacy leadership development program for *experienced physics master teacher leaders* both to support national initiatives through advocacy at the local, state, and/or federal level and to provide sustainability in leadership, funding, and vision for other AAPT K-12 PD&L programs.

The Task Force suggests three potential programs that address the three top priority areas, identified by the acronyms TPReP, PALs, and TLAA in the "Principles, Priorities, and Programs Diagram." Brief descriptions of these potential programs (illustrated on the following page) are included in the main body of the report.


Principle
PD&L programs must build strong **Networks & Community** characterized by:
• PD&L "for teachers, by teachers,"
• Support across the career spectrum,
• Support across the K-12 spectrum, and
• Participation from K-12 teachers, higher education faculty, professional associations for educators.
Priorities
Mentoring & Induction (secondary)
Vertical Alignment (K-12)
Program Support & Advocacy (K-12)
Programs
TPReP Teacher Preparation and Retention Program
PALs Physics at All Levels
TLAA Teacher Leader Agency and Advocacy
Emerging Teacher Leaders
These programs use transforming teacher leaders to build new capacity for leadership by identifying and supporting emerging teacher leaders.
Transforming Teacher Leaders
This program identifies existing teacher leaders who are looking to grow their leadership skills even further, and to support emerging teacher leader programs.

Preface

To develop plans to address the well-known lack of highly qualified K-12 teachers of physics, the American Association of Physics Teachers (AAPT) charged the Physics Master Teacher Leaders (PMTL) Task Force to ***create a new set of aspirational and professional development and leadership (PD&L) models for the K-12 physics education community.***

The emphasis of these programs begins with *leadership*, as it is only from a core group of teacher leaders that even more robust programs can be developed to serve the nation's 28,000+ high school and 3M+ K-8 teachers of physics.

The PMTL Task Force members believe that teachers can be each other's greatest resource for expanding effective teaching practices, advocating for change, and developing new talent. We have a diversity of experiences, in elementary, middle, and high schools around the country, yet we consistently see the same needs arise in physics education. Through an intensive process of sharing our aspirations, and winnowing ideas, we found that the needs we identified and our goals for addressing these needs were readily aligned. A common direction forward for the betterment of physics education became clear to us.

The Task Force members' experiences with teacher leadership, including multiple programs that have influenced or continue to influence us, helped to define a framework for teacher leadership in the context of physics education. From this framework, we identified the underlying principle and priority areas for programs that expand opportunities for teacher professional development and leadership through the AAPT. We also provided samples of specific programs that can address the identified priority areas.

This report is the summation of this process and represents both the Task Force vision and its commitment to action.

AAPT Physics Master Teacher Leader Task Force
May 2017

1 Building on Experience - The PMTL Task Force

The Physics Master Teacher Leader (PMTL) Task Force was composed of physics teacher leaders in elementary, middle, and high schools across the nation. The 17 physics teacher leaders were identified from a large pool of national K-12 applicants through a process that included the completion of an application and an interview.

The Physics Master Teacher Leaders (PMTLs) were selected on the basis of their physics leadership, educational practices, and their unique perspectives that they bring to the group. The networks of these PMTLs interconnect many organizations that have enhanced their physics teacher leadership experiences throughout their careers. Task Force members have a range of affiliations, including membership and participation with the American Association of Physics Teachers (AAPT) and its Physics Teaching Resource Agents (PTRA) program, the National Science Teachers Association (NSTA), and the American Modeling Teachers Association (AMTA), and have had experiences through a variety of physics summer instructional institutes across the nation. Amongst the group, there are Albert Einstein Distinguished Educator Fellows, STEM Board of Trustees members, Advanced Placement Physics consultants, and Presidential Awardees for Excellence in Mathematics and Science Teaching. All Task Force members have been recognized for their science leadership on the national, state, university, district, or school level and are educators who have demonstrated significant leadership in their careers. It is a task force of teacher leaders charged with suggesting ways to create more *teacher leaders.*

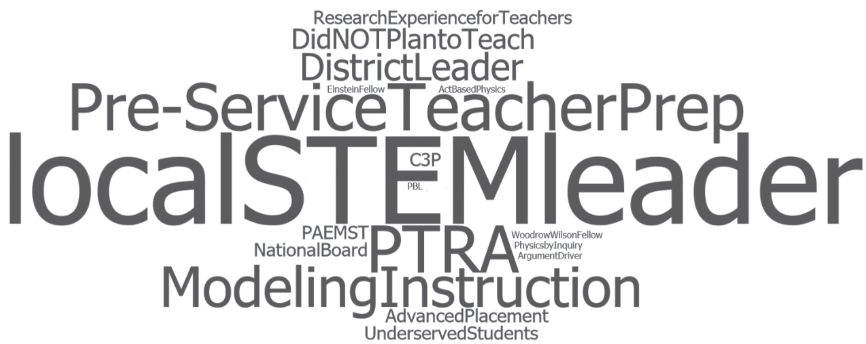
Based on an analysis of the Task Force members' paths in becoming master teacher leaders, the Task Force identified characteristics of teachers who are effective advocates for change. The Task Force also articulated the key steps the AAPT might follow to build a cadre of physics teacher leaders. The goal of the PMTL Task Force was to recommend a new set of professional development and leadership (PD&L) models for K-12 physics education, with an emphasis on engaging teachers as leaders in advocating for change.

The Role of an Early Catalyst and Intensive Professional Development Experience

During the first PMTL virtual meeting, commonalities in the experiences of Task Force members immediately emerged. The majority of members were set upon leadership paths by some catalyst that prompted them to seek programs to improve their practice as educators. In many cases, these were *positive* interactions—a mentor teacher who inspired them with their own passion, an administrator who saw in them some spark and encouraged them to seek additional training, or an inspirational article about physics education with information about how to learn more. In other cases, this catalyst was something *negative*—a grueling first year of teaching in isolation where the majority of lessons seemed to fail, an advisor who discouraged them from pursuing physics due to lack of aptitude, or a professional environment lacking support for innovation that spurred a PMTL member to do something (*anything*) to trigger change.

Regardless of what catalyst prompted each individual to seek more training, all PMTL Task Force members reported early involvement in a sustained and intensive professional development (PD) experience geared towards advancing their classroom practices. Members reported that participation in these programs had a transformative effect upon both their teaching and their views of themselves. These PD experiences commonly lasted two weeks or longer and involved extensive interaction with a group of like-minded educators dedicated to maximizing student learning in physics or other areas of science. In many cases, Task Force members subsequently became involved in a long-term community with the same initial cohort of educators, and shared best-practices with this group for years (or decades) afterward. Indeed, opportunities for sustained follow-up and face-to-face meetings with the cohort after the initial training were often embedded into these programs, and clearly valued (even treasured) by the teacher leaders.

Programs that had a transformative effect upon PMTL Task Force members were many and varied. As can be seen in the word cloud below, created from PMTL Task Force leadership biographies (found online at http://www.aapt.org/k12/Aspiring_to_Lead.cfm), the Physics Teaching Resource Agents (PTRA) program and Modeling Instruction were two of the most often mentioned formal STEM education experiences. In this word cloud, the larger the font, the more frequently the element was mentioned.



The Importance of the Network

As these early transformative experiences were discussed by Task Force members, the critical importance of being part of a community of supportive practitioners became apparent. It is unsurprising that PMTL members reported a reliance upon teacher networks to obtain feedback on content-related challenges, including issues such as where the most reliable equipment might be purchased, the optimal order and pacing for first semester physics, how to ensure classroom equity for diverse students, or how to overcome naive student pre-conceptions about force. Additionally, it is noteworthy that during their undergraduate careers, or even after receiving their degrees, a large portion of the PMTLs did not plan to teach. Furthermore, their own leadership paths often began at the invitation from a fellow colleague. Many of today's existing teacher leaders shared that their path toward teacher leadership had not initially been intentional, but was a product of their natural interests combined with encouragement from colleagues to pursue new opportunities.

These networks also became critical resources for PMTLs confronted with more general challenges: How is a supportive classroom environment created for all students? Is teacher burnout inevitable or can it be avoided? What is the impact of the testing and accountability movement on the STEM classroom? More importantly, PMTLs expressed that their early *social* interactions with peers during face-to-face professional development resulted in critical support beyond content and classroom environment issues. The opportunity for informal, after-hours conversations about teaching frustrations and dreams laid a foundation of trust that sustained teachers through many later career challenges.

Involvement in a teacher network prompted individuals to look beyond their own immediate classroom environment and contemplate their effect upon the robustness of STEM education as a whole. As one veteran PMTL observed, it is only after we can look beyond our own personal paradigm of effective classroom practice to what might advance the teaching profession as a whole that we become true teacher leaders. The focus of true teacher leaders must expand beyond what is effective for *our* classroom to what is effective for nearly *every* classroom in order for us to have a meaningful impact. Then teacher leaders must strive to *share* what they have learned with others in the field.

A special note must be made about networks and community-building for isolated and rural physics teachers. The majority of PMTLs reported that their most life-changing professional development and leadership experiences occurred as a result of multi-week summer institutes. Furthermore, research on professional development of teachers supports the effectiveness of community-building through cohort experiences of 80-120 hours of engagement. But not all teachers can take advantage of multi-week PD, so it is important to consider what elements of programs can support teachers through digital and shorter-term engagement.

Conclusions

PMTL members came to the conclusion that **the importance of the network/community transcends the importance of any other individual element** on the path to effective teacher leadership. Therefore, our ultimate recommendations consistently include **infrastructure for community interactions (either formally or informally)** as a fundamental component of any programmatic professional development work. This recommendation is supported by the foundational work on the *Diffusion of Innovations* by communications professor Everett Rogers (2003), who proposed that four main elements influence the spread of a new idea:

1. The innovation itself
2. Communication channels
3. Time
4. Social systems

As delineated in later sections of this report, members of the PMTL Task Force have proposed innovations they believe to be reflective of essential elements on the path to effective teacher leadership (item 1 above). What might be less apparent are the communication channels (item 2) and social systems (item 4) that will influence the spread of these proposed innovative programs. Task Force members encourage the AAPT to consider the importance of social interactions and communities (and their communication channels) in building effective professional development experiences for future teacher leaders.

2 Building on Success - Prior and Current Physics PD&L Efforts

Examples of Prior and Current Physics PD&L Efforts

The physics education community has invested over a century of effort in the improvement of physics teaching. Although the physics education research community has generally achieved consensus about how physics should be taught most effectively, there remain many obstacles for practitioners who actually want to use those approaches (Otero & Meltzer, 2016). Historically, many reform efforts have emphasized the physics curriculum—the development of textbooks and teaching resources—as a means to encourage teachers and students to engage in physics learning in novel ways. In the past few decades, these efforts began to shift more toward teacher networks, community, and identity rather than the adoption of any particular curriculum. More recently, attention has been drawn to the work of the physics education research community and effective pedagogies around which have been built a number of teacher-led networks (PhysPort, 2017). A brief list of some of the many efforts, identified by the PMTLs, is given below.

– Physical Sciences Study Committee (PSSC) Physics – PSSC was the first post-WWII national effort to re-shape high school physics education. Formed in 1956 by MIT Professor Jerrold Zacharias, the textbooks, films, and laboratory equipment that resulted from the work of the committee were broadly used in high schools through the 1970s, and some materials continue to be used today. Estimates suggest that upwards of 20% of all high school physics teachers were engaged with PSSC Physics. The impacts of PSSC on physics teaching is still felt today (AAPT, 2006).

– Harvard Project Physics (HPP) – HPP was a national curriculum development project to create a secondary school physics education program in the United States. The project was active from 1962 to 1972, and produced the *Project Physics* series of texts, which were used in physics classrooms in the 1970s and 1980s. F. James Rutherford, Gerald Holton, and Fletcher G. Watson directed this project.

– Physics Teaching Resource Agent Program (PTRA) – PTRA (also referred to as AAPT/PTRA) was formed in 1985 by members of the AAPT with the mission to improve the teaching and learning of physics and physical science for all K-12 teachers and students in the United States (AAPT, 2016). Using the train-the-trainer model, this program identified master physics teachers who spent one or more weeks each summer at an institute to learn about new teaching techniques and activities and develop workshops for dissemination throughout the remainder of each year. The program was initially funded by a series of National Science Foundation grants as it evolved to meet the needs of various teachers:

- 1985 to 1988 – Original PTRA Program
- 1988 to 1996 – PTRA Plus Program
- 1997 – Prototype Transition year
- 1998 to 2001 – Urban PTRA Program
- 2002 to 2009 – Rural PTRA Program
- 2010 – Math-Science Partnership Projects

AAPT/PTRA is recognized as the leading in-service physics and physical science professional development program for grades K-12 and received the American Physical Society's 2011 Excellence in Education Award for "providing peer-led professional development for 25 years to more than 5000 physics and physical science teachers nationwide." AAPT/PTRA maintains a network of experienced master-teacher leaders who attend yearly institutes in order to stay current on education standards, technology, and the latest physics education research. The infrastructure developed over the past 30+ years promotes strong partnerships with universities, colleges, businesses, informal science institutions, and K-12 schools across the country. The PTRA program is currently working with several organizations to promote authentic STEM experiences, which support the Next

Generation Science Standards (NGSS). Since 2003 data have been collected on both teachers and students of teachers attending the AAPT/PTRA institutes. The data indicate that teachers attending institutes had significant gains in their understanding of STEM content, implemented changes in teaching strategies, and integrated more technology in the classroom (Nelson, 2010). In addition, students of teachers attending the institutes had greater gains in achievement than did the students of teachers who did not attend the institutes.

Modeling Method of Instruction – Developed at Arizona State in the early 1990s (Wells, Hestenes, & Swackhamer, 1995), the Modeling method was designed to "correct many weaknesses of the lecture-demonstration method seen in STEM classrooms. These weaknesses include the fragmentation of knowledge, student passivity, and the persistence of naïve beliefs about the physical world" (AMTA, 2017). This method has students explicitly reflect on the nature of science and the construction of scientific knowledge, and has positive impacts on students' attitudes about science. Training in this method typically entails involvement at a three-week summer institute, with opportunities for teacher leadership as one becomes an experienced "Modeler." Through partnerships with universities, funding from various National Science Foundation grants, and high school teacher leaders themselves, over 9,000 teachers around the world have been trained in this method, and networks of teachers who use the method make up the membership of the American Modeling Teachers Association (an AAPT affiliate) and its regional daughter organizations such as STEMteachersNYC and STEMteachersPHX.

CASTLE – Capacitor-Aided System for Teaching and Learning is a curricular package with an underlying research-based approach to teaching about electricity and magnetism. The contents of the approach have been employed in teacher PD around the nation, most notably through the Rural PTRA project, as well as incorporated into the Comprehensive Conceptual Curriculum for Physics (C3P) program and workshops.

Comprehensive Conceptual Curriculum for Physics (C3P) – This project undertook a four-year research and development effort from 1993-1998 to produce a comprehensive, conceptually based physics program that integrated video-based, inquiry-based, and lab-oriented materials with findings from current research in preconceptions along with an effective pedagogy for use in physics teacher enhancement workshops. In the initial stage an oversight committee composed of physicists, researchers, and other experts was established to examine existing materials, such as Hewitt's Conceptual Physics, PRISMS, CASTLE, InfoMall, Physics Teach to Learn, and The Mechanical Universe, in light of research findings in physics education. The goal was to assemble the "best of the best" into a coherent, multi-faceted core curriculum for teachers of physics and to produce a workbook for student use. All the materials took an approach focused on identifying students' preconceptions and misconceptions and replacing them with sound concepts.

Activity-Based Physics – This project developed activity-based resources over the past two decades, and has included both high school and higher education professional development workshops held at various universities across the nation. Essential products for high school physics teachers include Workshop Physics, Real-Time Physics, Interactive Lecture Demos, and more.

Other PD&L Efforts – Beyond the physics education community, there are a variety of other STEM PD&L efforts that merit contemplation in planning for new PD&L for physics, including the Albert Einstein Distinguished Educator Fellowship, Knowles Science Teaching Foundation Fellowship, Math for America, the Presidential Awards for Excellence in Math and Science Teaching, the National Academies Teacher Advisory Council, and the Fulbright Distinguished Awards in Teaching Program (NRC, 2014). In particular, the Elementary Mathematics Specialists & Teacher Leaders Project (2011) is one such example from mathematics education that explicitly aimed to provide discipline-specific leadership opportunities. From these and other efforts, there are lessons to be gleaned.

In addition to the programs mentioned above, the physics education research community has developed a number of other curricular and instructional resources, around which have been built a number of summer institutes, methods courses, digital learning resources, and teacher networks that have contributed to the professional growth of many teachers. Examples of such resources have included Tutorials for Introductory Physics, Physics and Everyday Thinking, Investigative Science Learning Environment, Peer Instruction, Physics Union Mathematics, Responsive Teaching in Science, and much more (PhysPort, 2017).

Reflections from PMTLs

All of the aforementioned PD&L programs have impacted physics education on a national level, in addition to the many other programs that the Task Force members cite as having been instrumental in their own classroom practice and leadership. Although the charge to the Task Force primarily focused on future offerings as opposed to reflecting on the merits of current or prior programs, the past and current scope of impact of these programs must be considered when developing the next generation of coherent PD&L offerings for physics teachers of the nation. Implicit lessons from this listing of prior and existing PD&L programs suggest that future PD&L efforts must be supported by a (1) collective group of individuals and (2) researcher-practitioner partnerships in the development and execution of the programs.

Despite their wide dissemination, many once highly impactful programs have faded away in national prominence among the physics education community, in part, because they were led by a single champion or a very small group of leaders. Programs built with a narrow leadership structure face many challenges, including issues of scope and adaptation. With over 28,000 U.S. high school physics teachers alone, a coherent program of supports must rely upon a vast network of teacher leaders working locally and nationally. Additionally, single champions are often unable to adapt their programs to the ever-changing nature of education. The nature and population of the physics classroom is quickly changing even now, with more students of greater diversity taking physics than ever before, and national initiatives such as the *NGSS* resulting in classrooms that are significantly more interdisciplinary. PD&L efforts must be responsive to the current and changing needs of teachers.

Because many PD&L programs involve so many different elements in order to be successful (i.e., educational research, curricular development, workshop planning, fundraising, dissemination, implementation support, ongoing revision), a robust team of leaders with a diversity of skills committed to a unified effort is also necessary. While some PD&L programs were spurred by initiatives from higher education and funding for research, it is clear that partnerships between researchers and teacher leaders are essential. Teacher leaders are the primary experts as practitioners, and often serve as the most influential nodes in their networks of fellow teachers and teacher leaders.

> *"Looking back, from a personal perspective, at the above list of professional development institutes and materials, I participated in a number of them. Both the Physics Teaching Resource Agent Program and Activity-Based Physics were the most influential and effective into making me a better teacher, and I used materials from those and many other programs in my teaching career. This task force, to me, looks to embody and utilize the previous professional development programs for improving physics education. As a PTRA that is what I am looking to do every time I attend a workshop, present a workshop, or help design a workshop. ABP, C3P, CASTLE, and Modeling are examples of where my training as a PTRA has paid off. There are moments when I look at what is available for physics teaching and I just want to jump back in and begin my career. To me these professional development institutes provided me the materials and guidance to become a more effective teacher and educational leader."* —PMTL Steve Henning

3 A Framework for Physics Teacher Leadership

Framework Background - Setting the Stage

Early on in its work, the Task Force determined that master teacher leadership development requires a *continuum of experiences*, starting in the early career phase. Teacher needs differ at different points along the continuum, requiring distinct experiences for early-, mid-, and late-career teachers. However, these experiences should build upon one another and align with a coherent framework for teacher leadership. These programs should also leverage existing master teacher leaders' expertise in all phases: for novice teachers, this might mean receiving mentorship to help with instructional strategy; for late-career teachers, this could mean advising novice teachers on how to advocate for effective physics education policies. Regardless, master teachers should serve as integral components of this cycle, bolstering the community of master teachers.

The Task Force also emphasized the importance of networks and community across all programs. In discussions of effective programming, it was clear that social interactions among colleagues were critical to developing master teacher leaders. One PMTL described himself as a single node inside a powerful network, and his success was a function of that network's strength. Another PMTL described his social network as tightly inter-connected with his professional development community: one PD experience exposes a teacher to a new group of colleagues, with their own, unique set of experiences, who expose the teacher to new PD opportunities, continuing the cycle.

The Framework

The initial work of the PMTL Task Force was to identify the dimensions of teacher leadership. Through their discussions, the participants identified and discussed teacher leadership as manifest in the instructional, association, or policy realms. For each of these realms, Task Force members categorized behaviors demonstrated by both emerging and transforming teachers; *emerging* leaders are those teachers who are beginning to demonstrate leadership attributes, while teachers described as *transforming* have already demonstrated and/or have been recognized for their accomplishments in the instructional, association or policy realms. Synthesizing these perspectives, the PMTL Task Force developed a framework for physics teacher leadership that identified both the behaviors and attitudes of teacher leaders along a variety of dimensions, including sphere of influence (instructional, association, policy), experience (emerging and transforming) and level of engagement (local, state, national). Moreover, teacher leaders can be emerging or transforming at the local, state, or national level in any of the three areas. This framework builds on National Education Association's framework for teacher leadership (NEA, 2016), but is fine-tuned to the needs of physics teacher leadership. Programmatic ideas are built upon this framework's vision of a physics master teacher leader, creating a coherent continuum of experiences for novice to master teacher leaders.

Instructional Leadership

The majority of teacher leaders identify themselves as instructional leaders. Such teacher leaders believe that their pedagogical content knowledge is open to growth, they seek to improve their pedagogical content knowledge through reflective practice, and they learn about and provide research-based strategies for best practices for other teachers. Physics teachers who are emerging instructional leaders might attend local, state, or national meetings or events as an observer or an attendee, seeking ideas or mentorship from those experiences, and they implement initiatives in their classroom to improve their own practice. Physics teachers who are transforming instructional leaders also attend local, state, and national level meetings and contribute sessions to those meetings. They also lead initiatives to improve others' practice.

A special note should be added about teacher preparation. The PMTLs recognized that, ideally, pre-service teachers should build their own instructional practice long before student teaching, and that teacher leaders should have a role in teacher preparation, as is the case for many Teachers-in-Residence in Physics Teacher Education Coalition (PhysTEC, 2016) and Master Teachers in U-Teach (U-Teach, 2016) member institutions. Discipline-specific and research-based methods courses are essential. Although multiple PMTLs have experience as pre-service educators, they recognize that it is difficult for K-12 educators to change pre-service teacher education at the national level. Consequently, the current emphasis is on creating robust in-service teacher PD&L with the anticipation that similar programs will eventually be adopted by institutions of higher education responsible for pre-service teacher preparation.

The following are attributes of physics teachers who demonstrate Instructional Leadership at emerging and transforming levels:

Broad Mindsets and Beliefs

- Their pedagogical content knowledge is open to growth.
- They actively seek to improve their pedagogical content knowledge through reflective practice.
- They learn about and provide research-based strategies for best practices for other teachers
- They mentor novice teachers.
- They attend, plan, and present professional development to other teachers.
- They participate in professional learning communities and share ideas through face-to-face interactions (departmental/district meetings, workshops, conferences, mentoring) and media (journal publications, webinars, blogs, curriculum development).
- They move collaborative teacher groups (professional learning communities) towards impactful changes in their teacher practice (leading with confidence as opposed to merely sharing).
- They advocate for teacher leadership opportunities.
- They advocate for science education for all students.
- They integrate student-relevant and appropriate cross-curricular topics into science education.
- They seek and are aware of financial, technological, curricular, and instructional resources that support their teaching.

Instructional Leadership Performance Indicators	Emerging	Transforming
Local	• Participates in local professional development events as an observer/attendee. • Implements local initiatives (standards, missions) to improve own practice. • Remains connected to pre-service teacher education institution.	• Contributes a session, presentation, poster, workshop, or publication at a local science ed gathering. • Leads local initiatives (standards, missions) to improve others' practice. • Contributes to local pre-service teacher education institution through serving as a cooperating teacher, teacher-in-residence, and recruiter.
State	• Participates in state professional development events as an observer/attendee. • Implements initiatives (standards, missions) to improve own practice.	• Contributes a session, presentation, poster, workshop, or publication at a state science ed gathering. • Leads state initiatives (standards, missions) to improve others' practice.
National	• Participates in national professional development events as an observer/attendee. • Implements national initiatives (standards, missions) to improve own practice.	• Contributes a session, presentation, poster, workshop, or publication at a national science ed gathering. • Leads national initiatives (standards, missions) to improve others' practice.
Attitudes and Skills	• Seeks out support from other teachers and professional societies for survival. • Seeks out a personal mentor. • Learns about physics education research through readings and workshops. • Remains abreast of developments in science and recognizes content deficits. • Uses new approaches or strategies. • Understands that science is contextual, and connects to other subject matters, society, and culture. • Develops or modifies lesson plans to meet the unique learning needs of one's students. • Is aware of and works against implicit bias in the classroom. • Makes appropriate curriculum and instructional decisions based upon the available financial, technological, curricular, and instructional resources. • Utilizes culturally responsive teaching techniques to meet the needs of diverse learners. • Discusses new approaches with colleagues.	• Seeks out support from other teachers and professional societies for self-improvement in specific areas. • Reaches out to novice teachers who need help and extends a personal invitation to become a leader. • Implements physics education research-based practices by using them in the classroom. • Engages in authentic opportunities to deepen content knowledge (courses, research experiences, internships, etc.) • Uses multiple approaches or strategies from one's repertoire, and knows how to prioritize them. • Teaches science in context by making it relevant to students' lives and other aspects of the world. • Supports other teachers through the creation of curriculum and instructional resources. • Proactively works to promote social justice in science and physics education. • Seeks out funding for necessary teaching resources (grant proposal writing, requesting funds from department, being involved in renovation plans, etc.) • Encourages other teachers to be culturally-responsive in their teaching. • Models new approaches for colleagues, parents, and community (through invitations to the classroom, recordings, etc.), and helps others to move from awareness to implementation.

Association Leadership

Teacher leaders might also find national leadership opportunities through various professional teaching associations, such as the AAPT, NSTA, national teacher unions, the network of National Board Certified Teachers, or the organization of awardees of the Presidential Award for Excellence in Science Teaching (PAEMST). Additionally, teachers often find opportunities for leadership within local, district, and state professional teaching associations or regional sections of national associations, and non-teaching professional societies (i.e. such as the American Meteorological Association, The Optical Society, the American Physical Society, etc.). Teacher leaders use the associations as a way to develop an amplified voice, and they work to help all teachers succeed. Physics teachers who are emerging association leaders join and regularly attend association meetings at the local, state, or national level, and they represent themselves through their participation. Physics teachers who are transforming policy leaders serve in an elected or appointed role in a local, state, or national association. These teacher leaders represent others and speak on behalf of the science teaching community. They think and act strategically to enhance the experience of association members, and they are strategic thinkers working to improve the work of the association.

The following are attributes of physics teachers who demonstrate Association Leadership at emerging and transforming levels:

		Emerging	Transforming
	Association Leadership Performance Indicators		
Broad Mindsets and Beliefs • They look for opportunities to include others in the association. • They work in order to help all teachers to succeed, not just themselves in their own classrooms. • They use the association as a way to engage the community in education through an amplified voice. • They are strategic thinkers to look to improve the work of an association, not just to maintain status quo.	**Local**	• Joins and regularly attends local association meetings.	• Serves in an elected or appointed role in a local association.
	State	• Joins and regularly attends state association meetings.	• Serves in an elected or appointed role in a state association.
	National	• Joins and regularly attends national association meetings.	• Serves in an elected or appointed role in a national association.
	Attitudes and Skills	• Accepts invitations from others to take part in association leadership. • Represents own voice. • Takes on personal responsibilities for an association. • Supports the maintenance and growth of an association.	• Invites others to take part in association leadership. • Represents others and speaks on behalf of the science teaching community. • Builds a team of people (with redundancies) for shared responsibility in an association. • Thinks and acts strategically to enhance the experience of association members.

Policy Leadership

Teacher leaders might also find leadership opportunities in educational policy. Such teacher leaders understand the relationship between policy and classroom practices and they understand how to effectively advocate for good policy solutions. They recognize that teacher voice is both necessary and credible in policy discussions. Physics teachers who are emerging policy leaders understand the context of district, state, and federal policies. They can recognize the difficulties that arise from ineffective policy at these various levels, and they know how to shift from problem-focused to solution-focused thinking in regard to policy. Physics teachers who are transforming policy leaders take steps toward influencing departmental/school-wide, district-wide, state-level, or federal-level policies. They generate ideas through innovative thinking, and they share those ideas with stakeholders. They assure that teachers' voices are heard in policy discussions and they encourage other teachers to develop policy understanding and action.

The following are attributes of physics teachers who demonstrate Policy Leadership at emerging and transforming levels:

		Emerging	**Transforming**
	Policy Leadership Performance Indicators		
Broad Mindsets and Beliefs • They understand how to translate best practices from their classrooms into viable policy solutions (or, conversely, use policy to solve problems that exist in their classrooms). • They understand how to effectively advocate for good policy solutions. • They understand the interplay between policy and politics, and understand how to navigate situations that require one, the other, or both. • They have a strong network of professional contacts that can help them accomplish their policy/advocacy goals. • They are comfortable engaging with legislators and are willing to invite policy makers into their classroom (in-person or through videos, interviews, and anecdotes) to provide firsthand experiences of master teachers. • They understand both the current policy as well as the way this policy came to be and the issues it intended to address.	**Local**	• Understands the context of and implements local policy. • Identifies local policy and its hurdles (struggles, issues) that appear in the classroom as a result of "bad" policy. • Identifies local point persons who are levers for policy change (department chair, principal, superintendent, board members, colleagues). • Maintains an open-door classroom to keep a two-way conversation with policy makers.	• Influences and supports others to implement local policy. • Takes steps toward influencing departmental/school-wide policies. • Makes new opportunities and invites other teachers to join in local policy leadership. • Invites policy makers into the classroom experience to understand the impact of policy on education.
	State	• Understands the context of and implements state policy. • Identifies state policy and its hurdles (struggles, issues) that appear in the classroom as a result of "bad" policy. • Identifies state-level point persons who are levers for policy change (State Board of Education, state science supervisors, etc.).	• Influences and supports others to implement state policy. • Takes steps toward influencing district and state policies (including policies of state-level and advocacy organizations). • Makes new opportunities and invites other teachers to join in state policy leadership.
	National	• Understands the context of and implements national/federal policy. • Identifies national policy and its hurdles (struggles, issues) that appear in the classroom as a result of "bad" policy. • Identifies national/federal-level point persons and agencies that are levers for policy change (Department of Education, National Science Foundation, etc.).	• Influences and supports others to implement national/federal policy. • Takes steps toward influencing national/federal policies (including policies of national advocacy organizations like NSTA or AAPT). • Makes new opportunities and invites other teachers to join in national-federal policy leadership.
	Attitudes and Skills	• Recognizes that educational policy is more than legislation, and includes resulting implementation (i.e. school/district rules, curricular guidelines, standards, assessments, union rules, and historical tendencies). • Recognizes other teachers who are policy leaders. • Knows how to shift from problem-focused to solution-focused thinking in regard to policy. • Recognizes that teacher voice is both necessary and credible in policy discussions.	• Engages in policy work alongside teachers who have experience in policy leadership (as a support to others, and then later as a guide to others). • **Generates ideas through innovative thinking, and shares those ideas with stakeholders.** • Makes new pathways for teacher voice in policy discussions directly and/or with support of advocates.

Using the Framework

The Task Force aligned its PD&L program recommendations with the aspects of the framework to ensure that any recommended programs would incorporate instructional, association, and policy leadership opportunities to create a coherent structure for the development of physics teacher leaders. Task Force members felt that program ideas often focus on emerging leaders, with little structured support for those who are already demonstrating a transforming level of teacher leadership. Therefore, the Framework helped the Task Force be mindful to create a spectrum of opportunities for teacher leaders at various developmental stages in their careers.

4 Essential Elements of PD&L

While the PMTL framework provides a mechanism for identifying teacher leadership at various stages of development, the framework does not explicitly prescribe characteristics for professional development programs. The Task Force members identified such characteristics, arriving at a single underlying principle, which embodies four main characteristics of good PD&L.

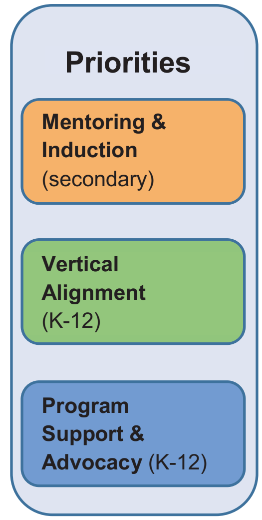
Fundamental Principle

Principle: PD&L programs must build strong **Networks & Community.**

This principle entails the following essential elements:

- ***Efforts that are "for teachers, by teachers," and incorporate the power of teacher-led cohorts.*** These programs should create, expand and support teacher networks to build and sustain the supportive community that is essential for teachers to thrive. Importantly, the leadership of these efforts should be placed with the teachers themselves.
- ***Support for teachers across the career spectrum, with mentorship for both new teachers and emerging teacher leaders.*** Too frequently, PD&L does not take into account the prior experiences and needs of new versus experienced teachers or teacher leaders. Programs should include coherent activities along the career spectrum, including programs for (a) beginning teachers of physics, (b) experienced teachers of physics who are ready to move into leadership positions, and (c) teachers who have leadership experience in local contexts and desire to expand their roles through instructional, association, and/or policy leadership. Additionally, this emphasis on teacher leadership should:
  - **Empower teachers to find their voice and become instructional, association and policy leaders** at the local, regional, and national levels.
  - **Sustain programs through a succession in leadership.** To that end, these programs need to train teachers to advocate for good teaching practices, policies, and funding to implement and sustain these programs across the nation.
- ***Engagement of both secondary and primary teachers who teach physics along with other STEM subjects for vertical integration.*** There is a demonstrated need for teachers at the K-8 level to effectively and consistently teach physics concepts, yet many elementary teachers have very little background in science in general and physics in particular.
- ***Embodiment of a grand scope and coherence in implementation.*** The programs should support teachers from introduction into the teaching profession through their years in service and as they develop into leaders who advocate for STEM education funding and effective policy. These programs should have local, regional, and national impact, and be supported by national organizations such as AAPT and by local colleges and universities (both two-year and four-year institutions) through teacher recruitment and preparation.

Priorities



Based on the fundamental principle characterized by the four essential elements, the Task Force identified three priority areas to strategically focus future AAPT programmatic development:

1. ***Mentoring & Induction:*** Support of novice secondary teachers through instructional leadership.
2. ***Vertical Alignment:*** Support of community-building for K-12 teachers through association leadership.
3. ***Program Support & Advocacy:*** Support transforming K-12 teachers through policy leadership.

These three priority areas exist as part of a continuum of experiences influencing teachers at all levels of their careers. These are the key recommendations for enhancing AAPT's K-12 professional development and teacher leadership programs.

Mentoring & Induction

This priority area explicitly builds on the theme of Instructional Leadership. The Task Force members all reflected on powerful experiences that happened early in their leadership journeys. As a result, they recognized that it is critical to focus on programs that mentor new physics teachers and support them as they work through the induction process. While such programs would focus on early-career needs like pedagogical content knowledge, general pedagogy, and meeting the normal demands of being a new teacher, they should also begin to cultivate a leadership mindset in early-career teachers, so that these teachers have some sense of what it means to be a teacher leader and to eventually take on leadership roles to support future generations of teachers. Such a program requires learning communities built around cohorts.

Vertical Integration

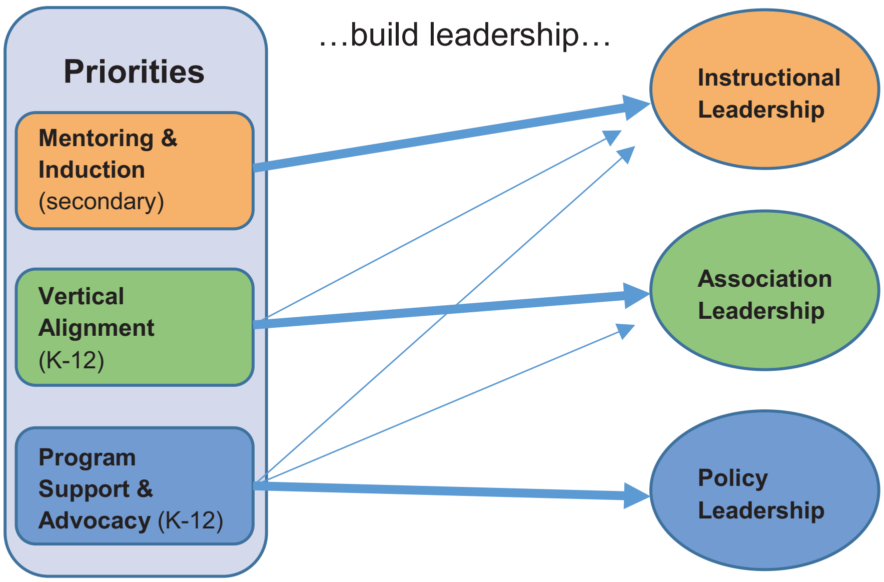
This priority area explicitly builds on the theme of Association Leadership, with extensions into Instructional Leadership. Given current initiatives like the *Next Generation Science Standards,* it is critical for all teachers, especially teacher leaders, to understand how their classrooms align with other K-12 physics classrooms and learning experiences. This second priority area focuses on creating experiences for in-service K-12 teachers that bring high school and elementary teachers together to support one another's teaching, recognizing that teachers can learn from each other across the educational spectrum even if districts do not align learning progressions themselves.

Program Support & Advocacy

This priority area explicitly builds on the theme of Policy Leadership, with extensions into Instructional and Association Leadership. The Task Force felt strongly that teacher leaders have a significant role to play in advocating for effective policies that support quality physics education, and for serving in specific leadership capacities to support existing PD&L focused on mentoring and induction and vertical integration. Because effective teacher networks are "for teachers, by teachers," it is essential to cultivate a core group of teachers who understand the national vision for educational change and programmatic strategy. Programs that support emerging teacher leaders, in particular, require the support of experienced teacher leaders who have leadership experience far beyond their own classroom, and who have skills necessary for designing and executing programs, as well as fundraising and advocacy.

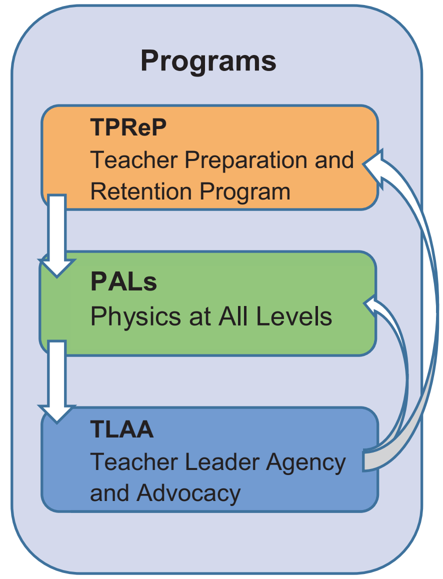
Priority and Program Integration with the Framework

In an effort to ensure that both the priorities for PD&L and programs derived from them meet the leadership needs of teachers across the career spectrum, the priorities were cross-linked to the framework. Each priority area places special emphasis on building one form of teacher leadership (denoted by the heavy arrows), but has extensions into other areas of teacher leadership (denoted by the lighter arrows).



5 Suggested Programs for AAPT PD&L

Program Interdependence



The Task Force decided to suggest models of programs that might address each of the priority areas, recognizing that in practice the programs will be interdependent. Although these are only suggestions (future work by the PMTL Task Force and others will develop more detailed plans for such programs), the Task Force believes that the suggestions illustrate how an association such as AAPT might use the priorities to guide its future PD&L efforts.

The Task Force recognized that leadership development requires a continuum of experiences, starting with novice physics teachers, or even pre-service training, and extending throughout a teacher's career. As such, it is critical to provide a series of professional development experiences for developing teacher leaders. Providing experiences for only pre-service teachers would miss out on the critical, mid-career development that emerging teacher leaders require. In addition, just focusing on transforming teacher leadership development (such as an advocacy program) would neglect the important development work during the early career stage. Both intentional and "accidental" leadership should be considered for early career teachers, and the programs should support both those kinds of teachers who tend to be particularly innovative in their approaches, as well as those who need support when they are thrown into positions of leadership such as department chairmanship or curriculum development leader. In addition, teachers may begin their leadership journeys at different points in their careers, with some teachers engaging in emerging leadership in early years, while others start later. Programmatic support for leadership development should recognize the diversity of leadership experiences, respecting specific needs at specific points in a particular teacher's journey.

However, these discrete programs must work together in a coherent fashion. It is critical for the novice teacher mentorship program to "plant the seeds" for leadership that middle and late career programs can develop further. In addition, alumni teachers who have worked through the continuum should have opportunities to participate as leaders in these programs, serving in a mentorship capacity. The AAPT should support all phases of this continuum via the three programs. The programs should also provide participation incentives for emerging teacher leaders. While intrinsic motivation may result in some teachers engaging in the programs, incentives could attract a larger population of teachers. Such incentives could include: graduate credits, continuing education units, financial support, recognition, free AAPT membership/perks, or some type of Physics Master Teacher Leader certification.

At the time of publication of this report, the AAPT is organizing an effort to more specifically define what potential programmatic models might look like. What follows is a summary of programs suggested by members of the Task Force.

Teacher Preparation and Retention Program (TPReP)

Example Program: The PMTL Task Force has identified supporting new secondary 9-12 teachers of physics as a priority for AAPT. This has been identified as a priority area due to the shortage of physics teacher candidates and highly qualified physics teachers in classrooms, as well as the fact that retention rates—even for highly qualified physics teachers—are not as high as they could be. One possible solution to support novice physics teachers is to use and/or modify existing professional development programs to create a coherent multi-year induction and mentoring program. Targeted teachers for this program are teachers who will be teaching physics for the first time, beginning as early as the summer after their graduation. The program should also include experienced teachers who are new to physics. The 400+ graduates from the 300+ Physics Teacher Education Coalition (PhysTEC) institutions across the nation should be targeted, because highly qualified teaching candidates have significant potential for impact. A program of coherent experiences for these teachers can be crafted from both new and existing programs, including the work of AAPT Physics Teaching Resource Agents (PTRAs), AAPT's national meetings, the AAPT eMentoring Program, and AMTA's 80+ Modeling Method of Instruction in Physics workshops offered around the nation each year.

Physics at All Levels (PALs)

Example Program: The PMTL Task Force has identified vertical alignment of elementary and secondary teachers of physics as a priority for the AAPT. This priority acknowledges that while there are often restrictions within schools and districts that make true curricular and instructional alignment very difficult, it is nonetheless important to encourage the interaction among K-8 and high school teachers for mutual benefit. One way to support the vertical integration of K-12 teachers is to create interdisciplinary teams of primary and secondary physics educators with high potential for leadership, and to help them build regional teacher cohorts. This program aims to be a connecting hub between the other two priority areas proposed by the PMTL Task Force (the TPReP and TLAA programs) as it supports teachers who are "in the middle" of the leadership spectrum—no longer novice teachers, but not yet ready for the full scope of advocacy, policy, and leadership at the national scale. Targeted teachers for this program could include science teaching recipients of the Presidential Award for Excellence in Math and Science Teaching (PAEMST), National Science Teachers Association awards, and National State Teacher of the Year awards. This program will engage already excellent teachers in leadership and teacher-led curriculum development, and take advantage of the strengths these teachers bring while supporting those who need more development in the physical sciences.

Teacher Leader Agency and Advocacy (TLAA)

Example Program: The PMTL Task Force has identified program support and advocacy as a priority for the AAPT. This has been identified as a priority area because of a need to increase the number of physics teacher advocates to effect change in physics education at the large scale, and to support the sustainability of any PD&L programs enacted. One way to support teacher leader agency and advocacy is to develop a networked Master Teacher-Leader Corps trained in advocacy, education policy and funding processes. We envision these teachers as respected leaders in their field who are able to (1) support AAPT initiatives and programs by both advocating for these programs and assisting in seeking funding opportunities, (2) build relationships with policymakers at the school district and state levels, (3) engage with their colleagues to empower these teachers to engage in advocacy on local, state and national levels, (4) keep a watchful eye on proposed policy changes and disseminate timely information allowing the education community to engage in effective advocacy efforts, and (5) serve on local, state, and national committees lending their voices to the education policy discourse. This program would serve as the capstone experience for emerging PMTLs, building upon the experiences of both TPReP and PALs. Teachers selected for this program should have a demonstrated record of excellence and, via the leadership development training of TPReP and PALs, a leadership mindset appropriate for advocacy at the local, state, and national levels.

Summary

This report's recommendations represent the PMTL Task Force's vision for how to focus, support, and use one of the greatest untapped resources in American education today: the collective expertise and energy of our best teachers. Of the many contributing factors to the current challenges in physics education, the disparate and unfocused approach to teacher leadership is one difficulty that we believe can be overcome. The teachers of the PMTL Task Force demonstrate that the desire and expertise for teacher leadership already exists, and that with robust networks of teacher leaders, our country's best practitioners will finally be able to act as more than the sum of their parts. We seek to put an end to the cycle of the constant reinvention of the wheel by isolated physics teachers across the country, and the short-sighted vision for teacher leadership that leaves far too many potential leaders undeveloped.

Through this report's three-part aspirational vision and by building the capacity for instructional, association, and policy leadership, accomplished teachers will be able to nurture novice teachers, support each other across the K-12 spectrum, and successfully drive national and local policy. All of this can be accomplished by harnessing and directing the untapped energy and expertise of teachers for the direct benefits of our students and our future.

Additional Resources

To learn more about the work of the AAPT Physics Master Teacher Leader Task Force, to access this report in an online format, or to view appendices, please visit the *Aspiring to Lead* report web page at http://www.aapt.org/k12/Aspiring_to_Lead.cfm

Appendix A: Why K-12? The case for including K-8 teachers in our work.

Appendix B: Why advocacy? The case for building teacher agency and advocacy.

Appendix C: Evaluating Leadership Models

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