SMTI National Conference

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Cincinnati, OH

National Task Force on Teacher Education in Physics

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American Physical Society
Need for High School Physics Teachers

Relative Demand by Field

**Fields with Considerable Shortage (5.00 - 4.21)**

<table>
<thead>
<tr>
<th>Field</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Severe/Profound Disabilities (Spec. Ed.)</td>
<td>4.47</td>
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<tr>
<td><strong>Mathematics Education</strong></td>
<td>4.46</td>
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<tr>
<td><strong>Physics</strong></td>
<td>4.39</td>
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<tr>
<td>Multicategorical (Spec. Ed.)</td>
<td>4.39</td>
</tr>
<tr>
<td>Mild/Moderate Disabilities</td>
<td>4.37</td>
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<tr>
<td><strong>Chemistry</strong></td>
<td>4.35</td>
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<tr>
<td>Mental Retardation (Spec. Ed.)</td>
<td>4.34</td>
</tr>
<tr>
<td>Emotional/Behavioral Disorders (Spec. Ed.)</td>
<td>4.31</td>
</tr>
<tr>
<td>Bilingual Education</td>
<td>4.31</td>
</tr>
<tr>
<td>Learning Disability (Spec. Ed.)</td>
<td>4.28</td>
</tr>
<tr>
<td>Visually Impaired</td>
<td>4.24</td>
</tr>
<tr>
<td>Dual Certificate (Gen./Spec.)</td>
<td>4.23</td>
</tr>
<tr>
<td>Hearing Impaired</td>
<td>4.23</td>
</tr>
<tr>
<td>Speech Pathology</td>
<td>4.21</td>
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Physics Teacher Education

For comparison, secondary teachers with a major in the field (2004):

Science (all) 77%
Math 61%
English 76%
Social Studies 79%

Source: Schools and staffing survey, National Center for Education Statistics
Demographics of High School Physics Teachers

• 23,000 Physics Teachers Nationwide
• 1,200 new physics teachers each year
• ~400 of these have physics major or minor

• Number taking physics growing by 1% per year
T-TEP Charge

- Increasing the number of qualified high school physics teachers – Are there generalizable, yet flexible, strategies that institutions can employ?

- Identifying best practice – Are there effective:
  a) strategies in recruitment
  b) models of professional preparation
  c) higher education systems of support during the first three years of teaching

- Research, Policy, Funding Implications
T-TEP Members

- Stamatis Vokos, Chair (Seattle Pacific)
- Eugenia Etkina (Rutgers)
- J.D. Garcia (University of Arizona)
- David Haase (North Carolina State)
- Drew Isola (Allegan Public Schools)
- Eugene Levy (Rice)
- Valerie Otero (University of Colorado)
- Mary Ann Rankin (University of Texas)
- Jack Hehn (American Institute of Physics)
- Warren Hein (American Association of Physics Teachers)
- Ted Hodapp (American Physical Society)
- Cathy O'Riordan (American Institute of Physics)
- Monica Plisch (American Physical Society)
- David Meltzer, Senior Consultant (Arizona State)
T-TEP Data Sources

- Consulted results of research in teacher education
- Analyzed multiple types of publicly available data
- Surveyed all 758 U.S. physics departments (79% response rate) to obtain quantitative teacher production data
- Interviewed faculty or staff in identified institutions to verify and enrich survey data
- Conducted 12 site visits to institutions
- Collaborated with APLU, AACTE, KSTF, ACS
- Gathered advice from teacher education experts, program officers at foundations, and policy makers
Site Visits to Promising Programs

Diversity in Geographic location, Size, Type, Mission, Demographics, and graduating large numbers of physics teachers (>2/year)
Findings

1. Few physics departments and schools of education are actively engaged in physics teacher education
Finding #1: Few are doing PTE

Distribution of Graduates Across Institutions

Phone Interviews and/or Site Visits

Number of Graduates in 2-yr Period

Finding #1: Characteristics (n = 578)

- No PTE program at Institution: 42%
- At least one PTE graduate in past 2 years: 20% (n=118)
- PTE Program with NO grads in past 2 years: 9%
- New PTE program-no grads yet: 3%
- Unknown: 3%
- PTE program at Institution but NOT connected with Physics dept: 3%
Findings (cont.)

Without exception, all of the most active physics teacher education programs have a champion who is personally committed to physics teacher education.

With few notable exceptions, these program leaders have little institutional support.
Institutional context appears to be a significant factor in the engagement of physics departments in physics teacher education.

Few institutions demonstrate strong collaboration between physics departments and schools of education.

Programs do little to develop the physics-specific pedagogical expertise of teachers.
Findings (cont.)

6. Few programs provide support, resources, intellectual community or professional development for new physics teachers.

7. Few institutions offer a coherent program of professional development for in-service teachers, even though most teachers of physics are not adequately prepared to teach physics.
How are physics teachers prepared?
Despite this grim national picture, we also found that
Findings (cont.)

There exist thriving physics teacher education programs that can serve as models and resources for other institutions.

- A program champion or a group dedicated to physics teacher education
- Active collaboration between physics and education departments
- A sequence of courses that are focused on the teaching and learning of physics
- Early teaching experiences led by the physics department
- Individualized advising of teacher candidates by faculty knowledgeable about physics education
- Mentoring by expert physics teachers
- A rich intellectual community for graduates
Recommendations

- **Commitment**
  - Physics and education depts., university administration, professional societies, funding agencies

- **Quality**
  - Focus on student learning in pre-college classroom

- **Capacity**
  - Multi-partner collaborations adopt bold strategies to boost number of qualified individuals going into teaching (STEM majors, career changers)
Recommendations—Commitment

1. Physics departments and colleges of education should recognize that they have individual and joint responsibility for the professional preparation of the physics teachers at their institution and should act accordingly.

2. Institutions that consider the professional preparation of STEM teachers an integral part of their mission must take concrete steps to fulfill that mission. Institutions should join national or regional organizations (e.g., PhysTEC, APLU) committed to improving the quality of physics teacher preparation.
3 Professional societies and foundations must provide support and a coherent vision for the joint work of disciplinary departments and schools of education in teacher preparation.

4 The National Science Foundation and the U.S. Department of Education should develop a coherent vision for discipline-specific teacher professional preparation and development.
To optimize the environment for students to consider teaching careers, as well as to maximize student learning and promote effective pedagogical practices, teaching in physics courses should be guided by findings published in the physics education research literature.

Physics teacher preparation programs must provide teacher candidates with learning opportunities and extensive clinical experiences that allow them to genuinely integrate knowledge of (1) the discipline of physics, (2) general pedagogy, and (3) physics-specific pedagogy.
Physics departments, colleges of education, school systems, and state Departments of Education should collaborate to provide mentoring to early career teachers.

States should remove general science teacher certification and replace it with endorsements in individual subject areas, and work with higher education institutions to create new pathways that allow prospective teachers to receive more than one endorsement without increasing the length of the degree.
Recommendations—Quality (cont.)

9 National accreditation organizations should revise their criteria to better connect accreditation with evidence of candidates’ knowledge of and skills with subject-specific pedagogy.

10 Education researchers should work to better define physics teaching quality and effective physics teacher preparation, as well as investigate the connection between student achievement and physics teacher knowledge, skills, and dispositions.
Physics departments, colleges of education, and school systems should collaborate to adopt specific strategies that have demonstrated success in increasing dramatically the number of individuals with extensive background in STEM disciplines who are prepared to teach physics effectively.

Physics departments, colleges of education, and school systems should collaborate to develop a course of study that targets all necessary components for learning a specific topical area of physics.
13 In collaboration with school systems, institutions or coalitions of institutions should increase their regional impact by pooling subject-specific teaching expertise and a diverse array of contexts to create communities of significant numbers of prospective and practicing physics teachers.
The national landscape shows a system that is largely inefficient, mostly incoherent, and massively unprepared.

Physics departments, schools of education, university administrators, school systems, state and federal government, as well as business and foundations have indispensable collaborative roles to play.

We have excellent models from a handful of isolated pockets of excellence.
Questions

- What can T-TEP do to help you with your work at your institution?
- What steps should T-TEP take to push the recommendations forward?
Project Partners

• National Science Foundation: PHY; DUE (MSP, ATE, CCLI, Noyce); DMR
• APS Campaign for the 21st Century
PhysTEC Project Goals

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

National Coalition

• National Conference
• Recognized Programs
• Community Leaders
• Sharing Innovative Ideas
• Broad Dissemination
• 180 member institutions

Demonstration Projects

• Comprehensive (<$100k/yr)
  • All key elements
  • Teacher in Residence
• Pilot sites (<$25k/yr)
  • Innovative ideas
  • Possible: TYC, LAs, TIRs
• National models
• Institutional support

www.ptec.org/taskforce
Increase in Physics Teachers Educated at PhysTEC Institutions

*Became a PhysTEC site 2003 or later
**Number of physics certifications averaged over 319 institutions in 15 states. Note that all PhysTEC teachers are more highly qualified than the minimum standards in most states.

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Arkansas Success Story

- **Physics Majors**
- **Physics Teachers**

Dramatic increase in majors enabled a large increase in physics teachers

- PhysTEC funding starts
- PhysTEC funding ends; program sustained locally

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Physics Teacher Education Coalition (PTEC)
Member Institutions

Institutions in red have received PhysTEC funding

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UTeach Students

Number of Students

Semester

28 48 85 125 180 234 292 331 328 341 377 407 434 472 473 462 434 449

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RFP Components

- Site Types (Pilot, Comprehensive)
- Funding (up to $25k, $100k/yr for 3 years)
- National Models
- Research
- Key Elements
- Expectations (reporting, data, meetings)
- Review process
- Timeline
Key Components

• Recruitment
• Master teacher (TIR)
• Course transformation
• Early teaching experience
• Learning Assistants
• Collaboration (physics, education, schools)
• Relationships with practicing teachers
• Sustainability
• Assessment
• Induction and mentoring

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Timeline

- RFP: October
- 2-3 page pre-proposal: 1 November
- Full (15 page NSF style) proposal: 1 January
- Funding decision: April
- Project Start: August

- PhysTEC 2011 Meeting: 23-25 May (held in tandem with UTeach Institute)
Leah Hesla had a bad case of physics envy. She was a symphony-caliber violinist with a musicology degree, working for a non-profit. She was unhappy and more so when meeting a physics major: “I would encounter someone in physics and say, ‘Oh, it looks like you were doing that,’” Hesla, 33, said. “I was jealous of those who were in physics and doing it.”

Hesla thought auditing physics classes would be enough. But for her, physics was the pot of gold at the end of the science. She couldn’t stop at one or two. At age 23, she was back in school but for a specific reason. “Other disciplines don’t explain why things happen,” Hesla said. “Physics does explain why.”

Hesla said it even explains the “why” of things we think we understand. “There’s a YouTube video of a stream of shampoo plopping into a pool of shampoo,” Hesla said. “It goes in and bounces way up and then goes in again and bounces some more. And you wouldn’t expect a bouncing behavior from shampoo. But it does and physics can explain that.”

Now Hesla’s off to Johns Hopkins for a masters degree in science journalism. Why? Yes, it’s still about the why. “I think I will find a lot of joy in giving the explanation about something in science to everyone else, so they can understand why,” Hesla said. “I might help discover something that influences government policy.”
Marketing Physics

Physics is like sex.
Sure, it may give some practical results,
BUT THAT’S NOT WHY WE DO IT.

RICHARD P. FEYNMAN—PHYSICIST

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