Department Chairs Meeting

12 June 2010
American Center for Physics, College Park, MD

PhysTEC Overview and Update

Theodore Hodapp
Director of Education and Diversity
American Physical Society
Shameless Advertisements

• Hallway Displays: Physics InSight
  www.aps.org/careers/insight
• Gender Equity Discussions
• Career Information
  CareersInPhysics.org
• Minority Bridge Program
  www.aps.org/mbp
• Graduate Education in Physics (Fall 2011?)
Need for High School Physics Teachers

Relative Demand by Field

Fields with Considerable Shortage (5.00 - 4.21)

- Severe/Profound Disabilities (Spec. Ed.) 4.47
- Mathematics Education 4.46
- Physics 4.39
- Multicategorical (Spec. Ed.) 4.39
- Mild/Moderate Disabilities 4.37
- Chemistry 4.35
- Mental Retardation (Spec. Ed.) 4.34
- Emotional/Behavioral Disorders (Spec. Ed.) 4.31
- Bilingual Education 4.31
- Learning Disability (Spec. Ed.) 4.28
- Visually Impaired 4.24
- Dual Certificate (Gen./Spec.) 4.23
- Hearing Impaired 4.23
- Speech Pathology 4.21

Calls to Action

• Rising Above the Gathering Storm:

**Action A-1:** Annually recruit 10,000 science and mathematics teachers by awarding 4-year scholarships and thereby educating 10 million minds.

**Action C-1:** Increase the number and proportion of US citizens who earn physical-sciences, life-sciences, engineering, and mathematics bachelor’s degrees by providing 25,000 new 4-year competitive undergraduate scholarships each year to US citizens attending US institutions.
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

Source: AIP Statistical Research Center
## TIMSS-Advanced Physics Performance

### Average Physics Performance of Advanced Science Students in All Countries

<table>
<thead>
<tr>
<th>NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.</th>
<th>NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATION</strong></td>
<td><strong>AVERAGE</strong></td>
</tr>
<tr>
<td>NORWAY</td>
<td>581</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>57</td>
</tr>
<tr>
<td>(RUSSIAN FEDERATION)</td>
<td>545</td>
</tr>
<tr>
<td>(DENMARK)</td>
<td>534</td>
</tr>
<tr>
<td>(SLOVENIA)</td>
<td>523</td>
</tr>
<tr>
<td>(GERMANY)</td>
<td>522</td>
</tr>
<tr>
<td>(AUSTRALIA)</td>
<td>518</td>
</tr>
<tr>
<td>(CYPRUS)</td>
<td>49</td>
</tr>
<tr>
<td>(LATVIA)</td>
<td>488</td>
</tr>
<tr>
<td>SWITZERLAND</td>
<td>488</td>
</tr>
<tr>
<td>GREECE</td>
<td>486</td>
</tr>
<tr>
<td>(CANADA)</td>
<td>485</td>
</tr>
<tr>
<td>FRANCE</td>
<td>466</td>
</tr>
<tr>
<td>CZECH REPUBLIC</td>
<td>451</td>
</tr>
</tbody>
</table>

INTERNATIONAL AVERAGE = 501

http://timss.bc.edu
Findings and Recommendations of the Task Force on Teacher Education in Physics

Stamatis Vokos
Professor of Physics, Seattle Pacific University
Chair, National Task Force on Teacher Education in Physics
“Teaching should be one of our most revered professions, and teacher-preparation programs should be among a university's most important responsibilities.”

(Chronicle of Higher Education, Oct. 9, 2009)

“I believe that education is the civil rights issue of our generation.”


Secretary of Education, Arne Duncan
T-TEP Charge

- Identify
  - Generalizable strategies to increase the number and quality of physics teachers
  - Best practices for recruitment, advising, professional preparation, induction

- Articulate research, policy, funding implications

- Develop strategy for initial dissemination of results to
  - All physics departments
  - All colleges/schools of education
  - Physics education research community
  - Funding agencies
  - News media, state and national policy makers
T-TEP Membership

- Eugenia Etkina (Rutgers)
- J.D. Garcia (Arizona)
- David Haase (NCSU)
- Drew Isola (Allegan Public Schools)
- Eugene Levy (Rice)
- Valerie Otero (CU)
- Mary Ann Rankin (UT Austin)
- Stamatis Vokos (SPU), chair

- Philip Hammer (AAPT)
- Jack Hehn (AIP)
- Warren Hein (AAPT)
- Ted Hodapp (APS)
- Cathy O’Riordan (AIP)
- Monica Plisch (APS)

Senior Consultant:
- David Meltzer (ASU)

Former members:
- Pinky Nelson (WWU)
- Jim Stith (AIP)
Other significant contributions to date

- Eric Brewe (FIU)
- Hunter Close (SPU)
- Charles Coble (APLU)
- Larry Coleman (UC Davis)
- Nicole Gillespie (KSTF)
- Howard Gobstein (APLU)
- Paula Heron (UW)
- Frank Kline (SPU)
- Ruth Krumhansl (EDC)
- Carolyn Landel (WA STEM Center)
- Kimberly Mitchell (Gates Foundation)
- Mel Sabella (CSU)
- Rachel Scherr (UMd)
- Lane Seeley (SPU)
- Peter Shaffer (UW)
- Gay Stewart (Arkansas)

... plus numerous others
T-TEP Data Collection

- Physics Teacher Production
  - collected and triangulated from several state and national sources (e.g., AACTE, state officials, AIP)

- Survey and Interviews of Physics Departments
  - Surveyed all 754 physics departments in the U.S. (response rate of 77% - 578)
  - Phone interview with 26

- Site Visits to Thriving Programs
  - 12 sites visited
Site Visits to Thriving Programs

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

44 mathematics and science majors were asked: “What would your professors in your major department say if you told them you wanted to be a high school teacher?”

- Professors at our university don’t value teaching
- There is a lack of respect in departments for K-12 teaching
- It is not considered a “full blown career”
- Professors would be angry
- Professors would say, “You’re wasting your talent”
- Professors would say, “Don’t do it”
- Professors would say, “Do it when you retire”
- K-12 teaching is not on the cutting edge of research
Findings: How are physics teacher prepared

<1/4 of universities reported recent physics certified graduates

Those that did, had very low graduation rates with <2 students per year, making it difficult to justify needed resources
Finding #1: Few are doing PTE

Few physics departments and schools of education are actively engaged in the recruitment and professional preparation of physics teachers.
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 #2: It takes a champion who cares

2 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.
Finding #3: Ph.D. granting departments produce fewer physics teachers

Institutional context appears to be a significant factor in the engagement of physics departments in physics teacher education.
Finding #3: Ph.D. granting departments produce fewer physics teachers

Physics departments award more than 200 bachelor’s each year from education programs
- About 150 from bachelor’s & master’s departments
- About 50 from PhD departments

<table>
<thead>
<tr>
<th>Undergraduate education program by highest physics degree offered.</th>
<th>PhD-granting departments</th>
<th>Bachelor’s and Master’s granting Departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have an education program</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>With graduates</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>No graduates</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>New program (no grads)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Missing degree data</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>No education program</td>
<td>99</td>
<td>70</td>
</tr>
<tr>
<td>Total</td>
<td>142</td>
<td></td>
</tr>
</tbody>
</table>
Finding 4: Little or no collaboration

Few institutions demonstrate strong collaboration between physics departments and schools of education.
Finding 5: No physics-specific pedagogy

Programs do little to develop the physics-specific pedagogical expertise of teachers.
Finding 6: Universities don’t support recent physics teacher graduates

Few programs provide support, resources, intellectual community or professional development for new physics teachers.
Finding 7: Little support for teachers who are teaching physics outside their major

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.
Findings Summary: A Grim National Picture

- Few are doing physics teacher preparation
- If they are there is an under-supported champion
- Ph.D. departments produce fewer physics teachers
- Little or no collaboration with Schools of Education
- Little or no physics-specific pedagogy
- Little support for recent graduates
- Little support for those teaching physics outside major
Findings Summary: A Grim National Picture

But wait!
There’s more!
Finding #8: There are things that work!

There exist thriving 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 # of qualified individuals going into teaching (STEM majors, career changers)
T-TEP Recommendations—Commitment

1) Physics and Education departments should recognize that they share responsibility for physics teacher education.

2) Institutions should join national consortia, e.g., PTEC, SMTI

3) Disciplinary professional societies should advocate and support discipline-specific teacher professional education.

4) NSF and U.S. Dept. of Education should develop a coherent vision for discipline-specific teacher professional education and support programs that address critical issues.
T-TEP Recommendations—Quality

1) Teaching at all levels should be informed by physics education research.
2) Experiences for teachers should integrate physics content, physics-specific pedagogy, and practice, with reflection.
3) Programs should support learning communities of teachers.
4) General science certification should be replaced with subject-specific endorsements.
5) Accreditation criteria should be revised to be based on subject-specific teacher preparation.
6) Physics education researchers should set research agenda for the study of teacher knowledge/skills/dispositions and meaningful student achievement.
T-TEP Recommendations—Capacity

1) Institutions should use multiple strategies for recruiting talented STEM majors into teaching careers.

2) Institutions should develop a course of study that strengthens all components of the teacher professional continuum (e.g., coherent offerings for inservice, as well as preservice teachers).

3) Institutions, school systems, business partners, STEM professionals, should pool subject-specific teaching expertise and contexts to create communities of practice (e.g., physics teaching and learning regional centers).
Summary

- 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.
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
Solving the Problem: Critical Components

Complex Collaboration Culture Shift

• Recruitment
• Early field experience
• Interactive engagement in intro course
• Mentoring (at all stages)

• Bridges between key groups (physics department, education school, school districts)
• Physics Education Research (PER) faculty
• Master Teachers (TIR)
• Financial support for prospective teachers (Noyce)
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.

www.PhysTEC.org
Arkansas Success Story

Dramatic increase in majors enabled a large increase in physics teachers

PhysTEC funding starts

PhysTEC funding ends; program sustained locally
Mentoring for PhysTEC Teachers

• Most new PhysTEC teachers are mentored by Teachers in Residence
Early Career Outcomes for PhysTEC Graduates*

*based on known outcomes for 87% of PhysTEC graduates
Physics Teacher Education Coalition (PTEC)

Member Institutions

Institutions in red have received PhysTEC funding

www.PhysTEC.org

©2010, T. Hodapp, Email: hodapp@aps.org
Coalition Activities

• National Conference on Physics Teacher Education:
  Mar 2009 Theme: *Institutional Transformation* (Pittsburgh)
  Feb 2010 Theme: *Policy/Diversity* (Washington DC)
  May 2011 Theme: *Building Sustainable Programs* (Austin)

• Physics Teacher Education Digital Library [www.PTEC.org](http://www.PTEC.org)

• National workshops of exemplar programs (RTOP, LAs, PCK
  -- April 2010, Teacher Quality -- Fall 2010)

• Regional workshops (PTEC-NC, Aug 07; PTEC-NW, Oct 08)

• Best-practice book to bring together information on Physics
  Teacher Education (2010 expected publication)

• Sponsoring: National taskforce on teacher education

• Coalitions with professional societies (ACS, APLU)
UTeach Students

Number of Students

Semester

19972 19982 19989 19992 19999 20002 20009 20012 20019 20022 20029 20032 20039 20042 20049 20052 20059 20062

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

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

• Recruitment
• Course transformation (Intro physics, education track)
• Early teaching experience (e.g., LA)
• Learning Assistants
• Induction and mentoring

• Master teacher (TIR)
• Collaboration (physics, education, schools)
• Relationships with practicing teachers
• Assessment
• Sustainability

www.PhysTEC.org
Timeline

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

• PhysTEC 2011 Meeting: 23-25 May (held in tandem with UTeach Institute; Austin, TX)
Physics Majors... Physics Teachers
Physics Teachers... Physics Majors
Is the ‘Why’ keeping you up at night? Her too.

Leah Hesla had a bad case of physics envy. She was a symphony-caliber violinist with a musicology degree, working for a nonprofit. She was unhappy and more so when meeting a physics major, “I would encounter someone in physics and say, ‘Oh I really wish I was doing that,’” Hesla said. “I was jealous of those who were in physics and doing it.”

Hesla thought audidling physics classes would be enough. But for her, physics was the potato chip of science. She couldn’t stop at one or two. At age 33, 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 pouring 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 to get a masters degree in science journalism. “Why? Yes, it’s still about the why,” Hesla said. “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.”
Physics is like sex. Sure, it may give some practical results, but that’s not why we do it.

Richard P. Feynman—Physicist

UT Physics

www.PhysTEC.org