

*Seeding change: the challenges of transfer  
and transformation of educational  
practice and research in physics*

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Beyond Student Transfer: Graduate, Post-doc, and Faculty Development  
and the Road to Sustainable and Scalable Inclusion of PER  
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# Abstract

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Academia appears to do a remarkable job at producing the next generation of research faculty. The long anticipated shortage of well-qualified researchers has not appeared.[1] At the same time, while there are calls to reform educational practices in college and university classrooms, we are not widely preparing our future faculty to develop or implement these research-based educational practices. What mechanisms exist to foster the development of such practices and the field of PER more generally? What are the resources and impediments to do so? This poster examines the interrelated problems of supporting the development of the field, and the 'transfer' of what is known from PER to the more general populace of physics instructors. Two programs are examined to highlight these interrelated issues: the Postdoctoral Fellowships in Mathematics Science Engineering and Technology Education and the Preparing Future Physics Faculty Program. Data on successes and failures of these programs will be presented and analyzed from a perspective of cultural change [2] and developing professionals [3].

1. Committee on Science Engineering and Public Policy (COSEPUP). (2000). Enhancing the Postdoctoral Experience for Scientists and Engineers. Washington DC: National Academy Press.
2. Sarason, S.B. (1989). The Creation of Settings and the Future Societies. San Francisco: Jossey-Bass Publishers.
3. Shulman. L.S. (1997). Professing the Liberal Arts, In Education and Democracy: Re-imagining Liberal Learning in America, edited by Robert Orrill. New York: College Board Publications

# The Problem

## Graduate Student and Post-Doctoral Preparation

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- Goal: produce professional physicists
- Traditional focus is on research:
  - *Graduate schools typically have seen their mission as producing the next generation of academic researchers- Cosepup '95*
  - *Graduate education at the doctoral level in the U.S. is a combination of study and apprenticeship. - AAU 2000*
- What about Teaching/ Education?
  - *Criticisms [of US graduate education] commonly heard today include ... emphasis on research over teaching; ... - AAU '98*
  - of 687 new faculty hires, 40% were at Ph.D. granting institutions, with the remainder at masters and bachelors granting institutions - AIP 2002
  - Meanwhile increased emphasis on education at R1 institutions and industry's appeal for skill sets developed in teaching - US Dept of Labor 1990; ABET 2000
- Education is fundamental pursuit of all professional physicists, and under-supported in grad / postdoc preparation
- What of dissemination of PER reforms, PER itself?

# Professional Characteristics\*

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I. **Service:** *to augment and contribute to society using specialized skills, knowledge and judgment bound to a particular community and domain of inquiry*

RESEARCH: trained to advance the field of physics, expanding what is known and practiced.

EDUCATION: muted theme; paltry teaching requirements; limited or absent training programs; a minimal supervision or feedback

II. **Understanding:** *the body of knowledge, the scope of what is known, tested, debated, and developed*

RESEARCH: in courses, labs, apprenticeships, graduate students develop an understanding of the research domain of physics.

EDUCATION: few opportunities to promote productive understanding of domain

III. **Practice:** *the purpose, or ends, of knowledge. To apply, to test, and to further what is known in the field requires practice*

RESEARCH: hallmark of a graduate / postdoc programs - apprenticeship

EDUCATION: highly variable; decoupled; lack of feedback

\* Shulman. L.S., Professing the Liberal Arts, in *Education and Democracy: Re-imagining Liberal Learning in America*, edited by R. Orrill. NY: College Board Publications, 1997

# Professional Preparation Cont.

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IV. **Judgment:** *Judgment bridges understanding and practice. Judgment is based on the ideological commitments of a profession.*

RESEARCH: coursework, labs, colloquia, conferences and professional journals help develop judgment skills in research

EDUCATION: little or no coaching on judgment in teaching is present -- too often teaching is approached *ad hoc*; no reflection on educational motive, practice, research

V. **Learning:** *Learning from practice informs understanding, practice, and judgment (cyclic)*

RESEARCH: group meetings, conferences and papers, shape judgment

EDUCATION: few mechanisms for reflecting on educational practice exist. Students tend to teach as they were taught. No discussion of scholarship of teaching / learning

VI. **Community:** *A community of professionals has distributed expertise across and responsibility for a domain. The community validates inclusion (of people and ideas).*

RESEARCH: well defined ; class cohort; a research group; as conference and disciplinary members; and ultimately as a contributors to the field

EDUCATION: no established or built-in community for preparation

# A cultural perspective

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Culture\*: historically evolving collective use of tools and practices according to norms and values of a given group

Settings\*\*: program success or failure depends upon two critical factors:  
(i) the initial structure of the program and  
(ii) the adaptation of that structure to local conditions

## Tools / Practices

To a gross approximation this is the subject of PER  
Examine PFSMETE: Post-doctoral Fellowships in Mathematics Science  
Engineering and Technology Education

## Practices / Norms

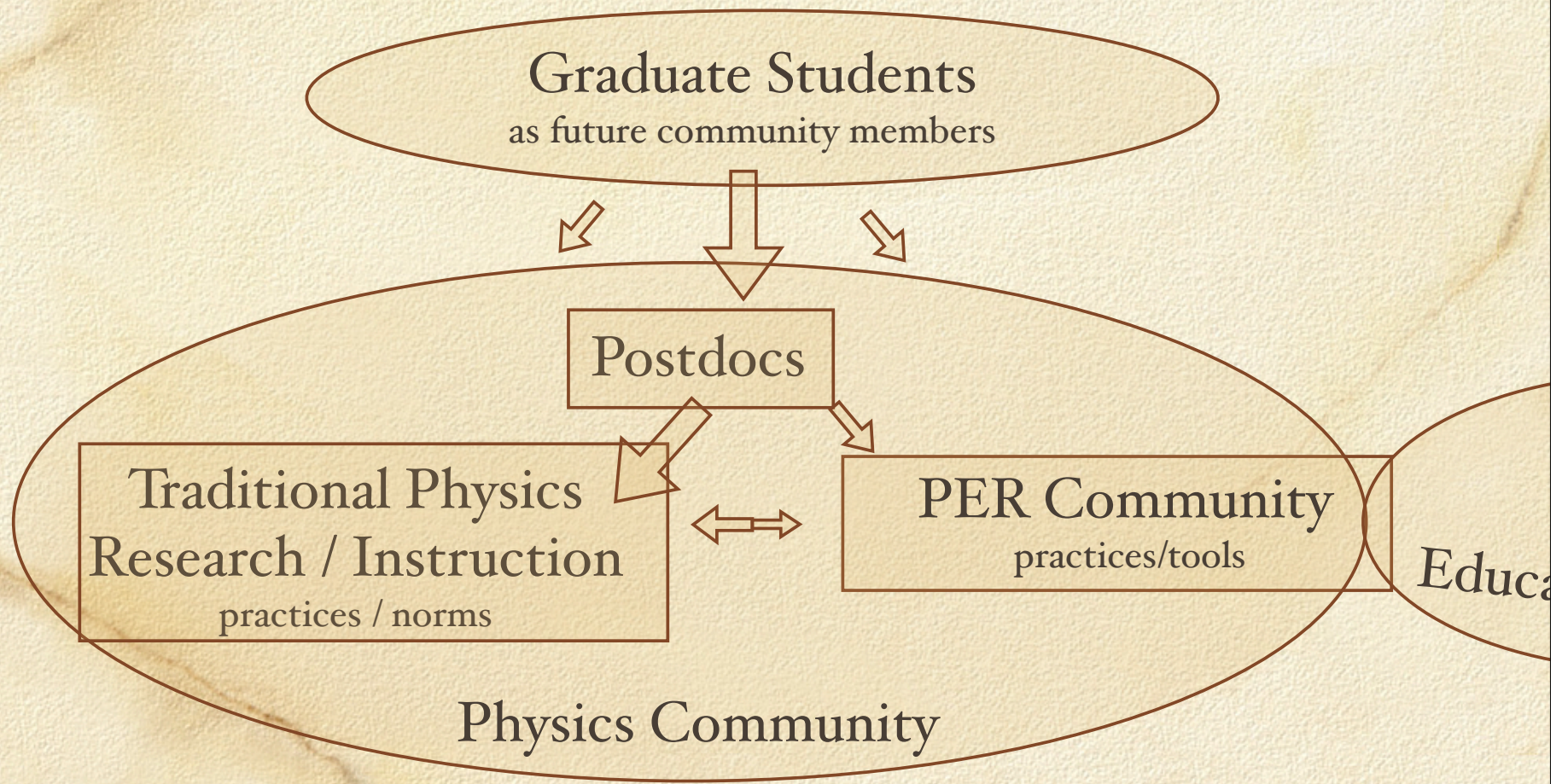
Broader work of AAPT / institutions where physics teaching is supported  
Examine training of future faculty in Preparing Future Physics Faculty Program

\* Cole, M. (1996). Cultural Psychology a once and future discipline (Harvard University Press: Cambridge, MA).

\*\* Sarason, S.B. (1989). The Creation of Settings and the future societies. (San Francisco: JosseyBass Publishers)

# A tiered approach

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# Preparing Future Physics Faculty\*

*to enhance the way academic departments prepare graduate students aspiring to an academic career for the full range of faculty roles and responsibilities in teaching, research, and service- AAPT website\*\**

## □ National Model (Preparing Future Faculty\*\*\*):

*“a configuration of ideas and national initiative, ... which has 3 core features:”*

[1] create a cluster of coordinated institutions, university - colleges ...

[2] addresses the full scope of rights and responsibilities [of faculty]...

[3] provide grads with multiple mentors for feedback ...in teaching

## □ UCSD Goals:

□ augment graduate preparation (experience, skills, and expectations)

□ build stronger ties with community (promote coordinated system)

□ promote education, reform, PER in departmental culture

□ do so in a sustainable fashion

\* B. Jones, E. Price and N. Finkelstein - Preparing Future Physics Faculty at UCSD

\*\*<http://www.aapt.org/Projects/pfpf.cfm>

\*\*\*<http://www.preparing-faculty.org/>

# PFPF Approach

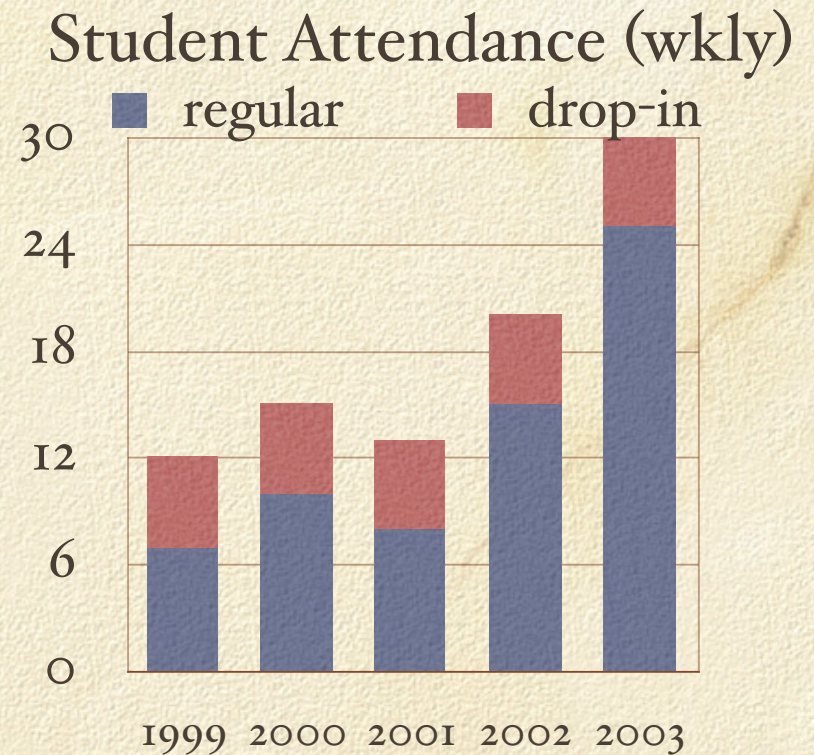
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- ❑ PEW Funded AAC&U / CGS program (since 1993); 5 disciplines-specific programs; AAPT admin. 4 physics sites
- ❑ 3 Years external funding for stipends (small) and pizza
- ❑ Begins outside physics dept; voluntary participation (students/ faculty)
- ❑ Tiered levels of participation (from peripheral participation to directing) - community / apprenticeship model\*
- ❑ Hub- Spoke Model: partnership with local colleges
- ❑ Weekly seminars on non-research elements of professional practice: teaching, education, grant writing, service
- ❑ Opportunities for professional practice (teaching) and feedback: observations, micro-teaching, guest lectures, outreach programs, co-teaching, instructor of record, PFPF directorship

\* Lave & Wenger Communities of Practice

# Evaluation: students' practice

- 7 students as instructors of record
- 20 as guest / co- teachers
- @ 6 different partner institutions
- support 3 different outreach programs; develop one.



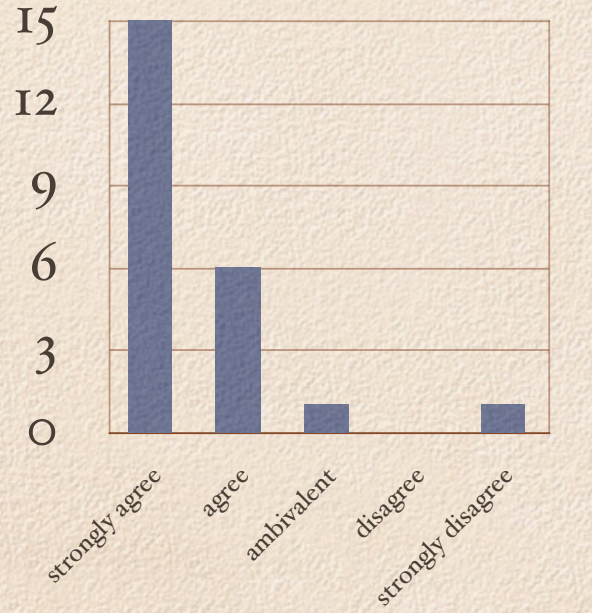
of 114 graduate students in physics department

# Survey\*: as a result of PFPF...

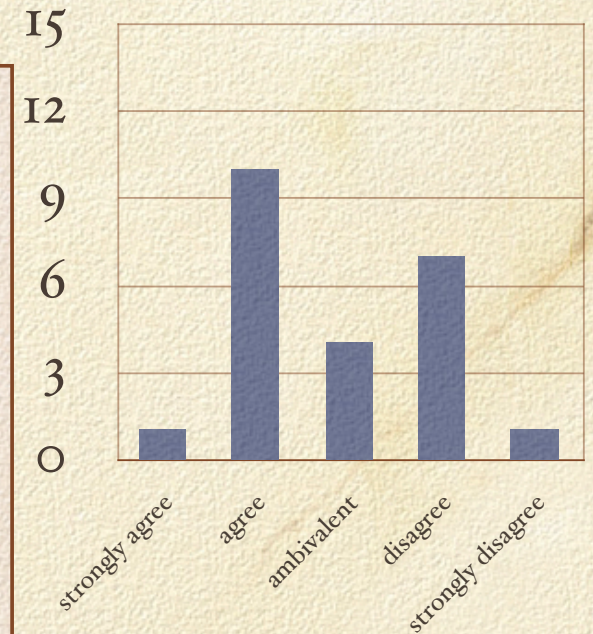
I consider education and teaching to be a substantive part of my future career.



I will incorporate the results of physics education research in my future teaching.



I am considering entering the education research field.



\* 23 responses from e-mail / forms distributed to 42 participants

# Survey high-lights

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- 21/23 consider education a substantive part of future career (agreed or strongly agreed)
- Of those 21, only 3 felt education was valued by the physics research community
- Of the 21 Who Consider Education a Substantive Part of Future Career:
  - 16 report  
being more aware of the results of PER (11 strongly)
  - 20 report  
planning to incorporate those results in teaching (14 strongly)
  - 19 report viewing PER as a legitimate activity legitimate research activity w/in  
the physics community
  - 10 are considering entering PER

# Evaluation: institutional response

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- ❑ Increased faculty participation - begin with 2; 10 faculty participate (intermittently)
- ❑ Local funding (\$10k → 5k/ year)
- ❑ Incorporated into graduate requirements: fulfills undergraduate teaching requirement
- ❑ Shapes TA training; supports development of PER group; supports/ effects reform of undergrad courses
- ❑ Directed by PFPF graduates

# Postdocs

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*It is really essential for the universities to recognize the value of the postdocs to their institutions .... They would not be the institutions they are today without the work of the postdocs, but I don't think that most of them recognize that. "Funding agencies also need to recognize the value of the postdocs to our nation both for the work that they are doing now and the work that they will do in the future when they become the great scientists and leaders of US science"*

--Maxine Singer, President, Carnegie Institute of Washington, and Chair, Committee on Science Engineering and Public Policy, COSEPUP Convocation 3/2/2001 - -- 5:00 - 5:40 in closing remarks

# NSF - PFSMETE:

Postdoctoral Fellowships in Science Mathematics, Engineering, and  
Technology Education (NSF- Pipsqueak)

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introduced by the NSF in 1997

primary objectives:

- (i) preparation of new science Ph.Ds for leadership roles in SMET education
- (ii) through the development of expertise in science education research

**NSF RFP:** development of creative teaching methods, innovative teaching materials for new concepts, quality education products ... [with demonstrated] utility to the education community as evidenced by sponsored studies of school systems and evaluations of higher education programs

**Structure:**

3 funding rounds, 63 Fellows

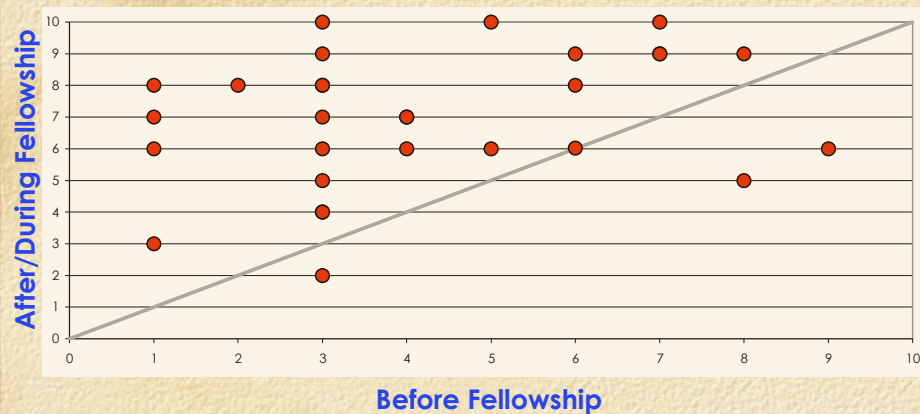
Defunded in 1999

Fellowship model (vs. research assistantship)

Research of Fellow's design; identify host institution and mentor

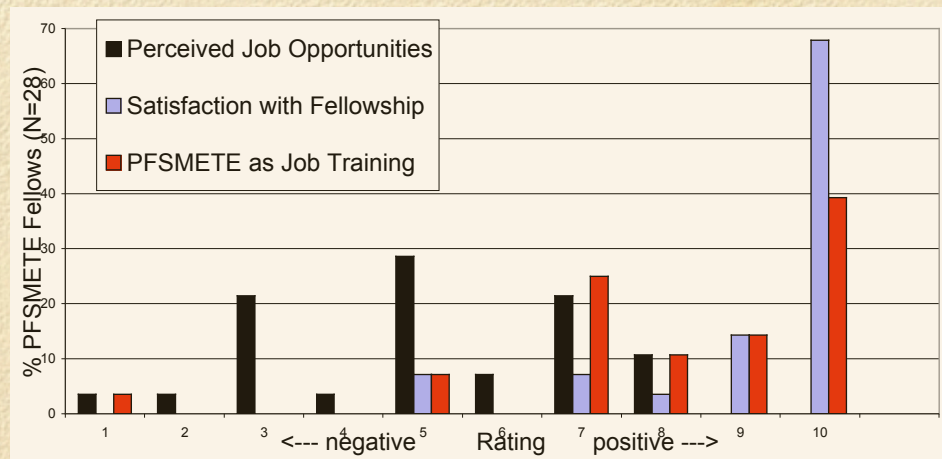
Broad range of sciences and host-environments (science depts, ed. schools)

# PFSMETE Survey (2001)



Perceived Interaction with Education (programs, research, etc).

Evaluation of program success



# Human side of PFSMETE?

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- What role has PFSMETE had in PER?

- Alicia C. Alonzo ('99 Physics)
- Bruce B. Birkett, II ('97 Physics)
- Scott W. Bonham ('97 Physics)
- Andrew R. Elby ('97 Physics)
- Noah Finkelstein ('98 Physics)
- Scott V. Franklin ('97 Physics)
- Elaine Su-Eng Fu ('99 Physics)
- Apriel K. Hodari ('97 Physics)
- Leonardo Hsu ('97 Physics)
- Beth Hufnagel ('97 Physics)
- Gregory R. Schultz ('98 Physics)
- Bentley J. Saylor ('97 Atmospheric Science)
- Kimberly D. Tanner ('98 Neuroscience)

- Of 63 Fellows in all of math, science, engineering and technology

# An integrated approach to change

physics  
graduate students  
PFPF

postdocs  
PFSMETE

Traditional Physics  
Research / Instruction  
practices / norms

PER Community  
practices/tools

Physics Community

Education

# Revisiting professional preparation

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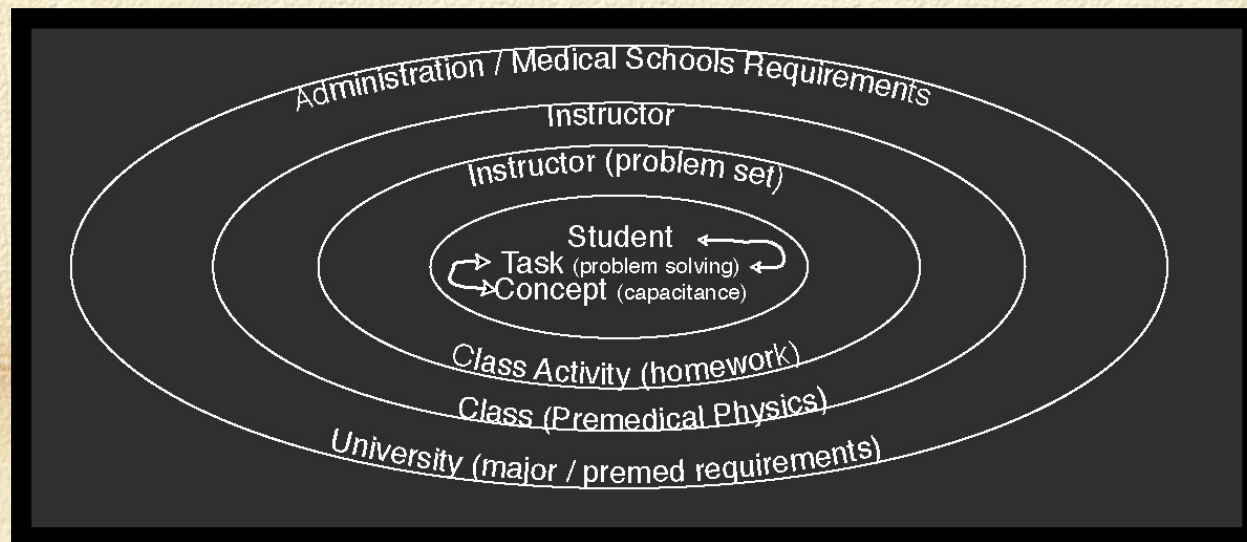
- I. Service: education included in role of adequately prepared students - (graduate and postdoctoral)
- II. Understanding: seminars research & apprenticeship provide opportunity to develop understanding
- III. Practice: support and guide experiences: from 5 minute micro-teach to multiple semester course to research in domain
- IV. Judgment: built-in mentorship and feedback mechanism to develop judgment in teaching and education
- V. Learning: experience teaching; learn the process of learning in education; research on tools, practices of PER
- VI. Community: build support system, culture, and space for discussions of education (as an intellectual enterprise)

# Challenges

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- ❑ External pressures
- ❑ Particularly funding
- ❑ Challenges to current norms / practices/ power structures.

## Context of Reform



# Conclusions ---

## change is possible, perhaps not probable

- Without radical revision of education system, it is possible to complete graduate student preparation by including teaching and education within the scope of the profession and to include legit. participation in physics education research
- No significant resources required to create sustainable program
- Nonetheless strong resistance lies in the structure (inertial, financial, and political (power structure)) of existing systems
- Requires bottom up (students and faculty interest; appropriate activities and discussion) and top down (institutional support; faculty; \$\$; incorporation into requirements)
- Mechanism for bringing about (positive) change in department more broadly