Discovery Learning Research Center
Advancing research that revolutionizes learning
Showcase & Symposium
February 22, 2011

Nancy Pelaez
Associate Professor of Biological Sciences, Purdue University
Program Director, 2006-2007
Division of Undergraduate Education
National Science Foundation

Where discoveries begin
Opportunities for Funding

Catalyzing Community Change in Undergraduate STEM Education

James P. Collins, Assistant Director, Biological Sciences Directorate
Linda L. Slakey, Director, Division of Undergraduate Education

17 July 2009 – Vision & Change in Undergraduate Biology Education
Challenge: Catalyzing Community Change in STEM Education

“This is how we will lead the world in new discoveries in this new century. But I think all of you understand it will take far more than the work of government. It will take all of us. It will take all of you. And so today I want to challenge you to use your love and knowledge of science to spark the same sense of wonder and excitement in a new generation.”

President Barack Obama
National Academy of Sciences 146th Annual Meeting, Washington DC, April 27, 2009
Moving the agenda forward

Thinking beyond the individual project

Leveraging resources

Working at a national scale
CCLI: Transforming Undergraduate Education

- Type I $200,000 for 2 to 3 years. ($250,000 when universities collaborate with two-year colleges)
- Results are expected to be significant enough to contribute to understanding undergraduate STEM education. Proposed evaluation efforts should be informative with respect to student learning or engagement.
- Next Deadline for Type I proposals: May 26, 2011
STEM Talent Expansion Program (STEP)

- Increase recruitment, retention, and graduation of STEM majors.
- Type 1 grants are at the institutional level.
- Type 2 awards support research on persistence to degree.
The Federal Environment for STEM Education Programs: Implications for TUES

& Some PI suggestions

Myles Boylan
Division of Undergraduate Education
National Science Foundation

CCLI PI Meeting January 28, 2011
America COMPETES: a bipartisan bill
many requirements, more NSF funding

- **Federal R&D & Innovation are vital** (10% annual increases authorized for research)
- **Workforce issues given emphasis**
  - Broadening participation in STEM (e.g. new HSI-UP program authorized); mentoring; renewing $;
  - Teacher Preparation (Noyce) 10,000 more tchrs
  - Improving schools, education, through complex partnerships (e.g. Noyce “10A” Program)
  - Emphasis on more STEM degrees (ATE, STEP, Professional Sci Masters, GRF, IGERT)
  - Required reports for some NSF STEM programs, summarizing effectiveness
Particular Features of American COMPETES (NSF covered by Title VII)

- Program extensions for STEP and Noyce described in full detail (is there a next step?)
- STEP-like programs also authorized for the US Dept of Energy (nuclear and fossil fuel)
- Ethics education required for students and postdocs on NSF grants
- Urges meeting critical national STEM needs for innovation -- be bold, seek value
- CCLI (now TUES) not mentioned, despite its ability to deliver quantity through quality (and innovation)
NSF Responses (New Emphases):

- Innovation = transformative research & education
- Explore promise of cyber-enabled learning; NSDL
- Renewed concern about sustainability of projects

- Examined & redesigned CCLI, NSDL
- Renewed emphasis on assessment and evaluation needed to capture value derived from a large variety of CCLI/TUES projects
  - New materials
  - New teaching methods
  - Faculty professional development
Cyclic Model for Creating Knowledge and Improving Practices in STEM Education

- New Materials and Strategies
- Increase Faculty Expertise
- Implement Innovations
- Assess And Evaluate
- Research on Teaching and Learning
Currently: a new 2010 NRC RAGS report, a new America Competes bill, & a new GAO Report (started)

Same NRC team asked to review 5-year progress. Result: RAGS, Category 5!

- unanimous view of each of the committee members: “our nation’s outlook has worsened.”

- Re STEM grads: “the race for quantity has already been rather decisively lost.”
Two RAGS Ominous Factoids

• Merck used to outsource production, now it also outsources much of its R&D

• China has replaced the United States as the world’s #1 high-technology exporter

“What must be preserved in the United States, if the nation is to compete, is an adequate supply of scientists & engineers who can perform creative, imaginative, leading-edge work - who can innovate.”
The new “Competes” bill (01/2011)

The Director of OSTP shall

- Establish a committee under the NSTC & OMB to coordinate Fed STEM Ed programs and avoid duplication

- Create 5-year strategic plans to specify and prioritize objectives, specify common metrics to measure progress, and describe approaches to be taken to assess effectiveness of agency programs.
This new oversight is already taking place!

Carl Wieman is actively involved in the evaluation of STEM Ed programs at NSF

OMB is also taking a detailed interest

Emphasis is shifting from summative evaluation to a preference for evaluation design that provides feedback for program improvement. [However, there is still a need for summative evaluation.]
This new oversight is already taking place!

Carl Wieman is actively involved in the evaluation of STEM Ed programs at NSF

OMB is also taking a detailed interest

Emphasis is shifting from summative evaluation to a preference for evaluation design that provides feedback for program improvement. [However, there is still a need for summative evaluation.]
New Competes, Section 527: “21st Century Graduate Education,” urges:

- NSF support future faculty training programs in STEM education [Note: have been doing this on a ltd basis thru PFF a decade ago, CCLI, & CIRTL.]

- NSF urged to research & assess the effectiveness of programs to teach grad students about modern STEM Ed practices [One Type 3 effort is funded]
The Challenge to TUES

If this program is truly transformative it should have discernable impact on student learning and achievement - even at the national level.

Several studies are showing some impact but most still have a long way to go.

A major challenge is to ensure program impact. There are 3 or 4 factors that jointly determine the long-term impact.
The TUES Impact Ingredients

1) Promising new materials and practices

2) Effective means for measuring their impact on students (lots more to do) [the “core.”]

3) Effective dissemination practices, both raising awareness, and professional development [“culture”]

4) Scaling-up within and across institutions [“community”]
Key TUES Challenge: Diffusion of Effective Practices

- Each component can help diffusion, e.g.
  - Evaluation data showing effectiveness [“core”]
  - Faculty professional development [“culture”]
  - Inter-institutional learning communities [“community”]

- Ease of implementation seems to be a key factor

- Diffusion prospects for complex innovations are more problematic

- Scaling-up must be planned from the start
Impact Challenges

- Time and complexity are real barrier [e.g. faculty teachers can’t spend 10K hours]
- Course interdependencies; service expectations in other departments
- Traditional time allotments for courses
- Departmental values may trump stated institutional priorities (or vice versa today)
- Course innovators not always skilled at dissemination and scaling-up
Impact Challenges (2)

- Replication in different types of institutions often not best fit for students, instructors.

- Target faculty would often prefer to collaborate in some form of reinvention of the original innovation – a reason why NSF values partnerships (like student learning).

- Innovation may mutate during reinvention, losing some of its effectiveness (clickers for example – easy to use, not use well – need good concept tests).
Thus, a TUES Challenge is Diffusion of Effective Practices

Questions - How many of you:
1. Are relatively new to grant supported work on undergraduate education (3 yrs or less)?
2. Were recruited or inspired to this work by other faculty members?
3. ----- as graduate students?
4. have been doing this work for 10+ yrs?
5. ----- 20+ years
PIs Advice to New Applicants

- Case studies are effective for teaching the process of science and recruiting interest
- Consider using professionals to do your dissemination ("marketing")
- Think about scalability across institutions from the start of a Type 1 proposal
- Focus institutional change efforts on young faculty
- If possible, design improved materials modularly so that they can be imbedded into a variety of existing courses
Where discoveries begin
Grants examining, facilitating large scale ups

1059235, Norman Fortenberry, NAE, “A Forum on Characterizing the Impact and Diffusion of Engineering Education Innovations.”

1022789: Barry Stein, Tenn. Tech., "Expanding Use of the CAT: Assessing and Improving Critical Thinking.”

1022186: Charles Henderson, Western MI U, “Collaborative Research: From Dissemination to Adoption: A Study of the Instructional Change Process in Faculty Most Likely to Succeed.”

Collaborative Research: From Dissemination to Adoption: A Stud...

0950224: Heidi Schweingruber, NRC, “Evidence on Selected Innovations in Undergraduate Science, Technology, Engineering, and Mathematics Education”


091924: Cynthia Finelli, U of MI, “Motivating Change in Faculty Teaching Practices to Support a Diverse Student Body in Engineering.”

0934453: Heidi Schweingruber, Status, Contributions, and Future Directions of Discipline Based Education Research"

0937784: Flora McMartin, Broad-based Knowledge, "Learning from the Best: How Award Winning Courseware has Impacted Engineering Education," (NSDL funded)

0918881: James Maxwell, AMS, "CBMS2010: A Study of Undergraduate Programs in the Mathematical and Statistical Sciences in the United States and the Publication of the Results" (funded with DMS)
Grants examining, facilitating large scale ups - 2

0837121: Roberta Spalter-Roth, "Innovation in Digital Libraries: An Experimental Examination of the Production, Diffusion, and Use of STEM Teaching Materials."

0814328: Norman Fortenberry, NAE, “Developing Engineering Faculty as Leaders of Academic Change.”


0732521: Susan Millar, U of WI, "Toward a National Endeavor to Marshal Postsecondary STEM Education Resources to Meet Global Challenges: A Planning Proposal."


0613426: Robert Mathieu, U of WI, "Building Capacity for Course, Program, and Department Evaluation: Improving and Expanding the Student Assessment of Learning Gains Site."

0623009: Charles Henderson, Western MI U, “Facilitating Change in Higher Education: A Multidisciplinary Effort to Bridge the Individual Actor and System Perspectives.” (SBE)

There are more! Including outside studies.