Science faculty and educational researchers: Divergent expectations as barriers to instructional change

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Abstract

Science education research practitioners have engaged in substantial curriculum development and dissemination work in recent years. Yet, it appears that this work has had minimal influence on the fundamental teaching practices of the typical science instructor. To better understand this situation, interviews were conducted with five physics instructors who were considered to be likely users of science education research. All reported making changes in their instructional practices and all were influenced, to some extent, by educational research. Yet, none made full use of educational research and most had complaints about their interactions with educational researchers. In this poster we describe how these instructors used educational research in making instructional decisions and identify divergent expectations about how researchers and faculty can work together to improve student learning. Although different instructors emphasized different aspects of this discrepancy between expectations, we believe that they are all related to a single underlying issue: science education researchers typically seek to disseminate curricular innovations and have faculty adopt them with minimal changes, while faculty expect researchers to work with them to incorporate research-based knowledge and materials into their unique instructional situations.

Current Study

- Open-Ended Interviews
  - Five physics instructors, four institutions
  - Tenured
  - No formal connections with science education research
  - Thoughtful, reflective, well-respected

➔**This type of instructor is highly likely to be interested in educational research**

Adoption-Invention Continuum:

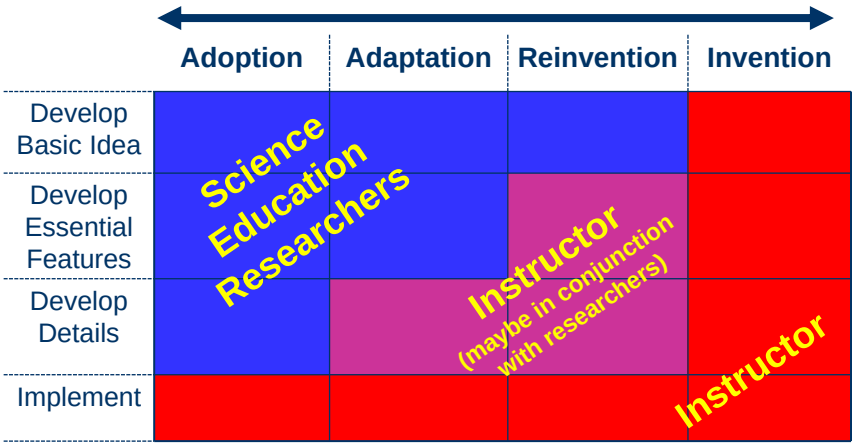
Possible Relationships Between Researchers and Faculty

Adoption	Adaptation	Reinvention	Invention
The change agent develops all of the materials and procedures and gives them to the instructor to implement as is.	The change agent develops the materials and procedures and gives them to the instructor who changes them slightly before implementing.	Instructor uses the ideas of the change agent but significantly alters them or develops fundamentally new procedures based on the change agent ideas.	The instructor develops materials and procedures that are fundamentally based on his/her own ideas.

For More Details: Henderson, C. and Dancy, M. (2008) Physics Faculty and Educational Researchers: Divergent Expectations as Barriers to the Diffusion of Innovations, *American Journal of Physics (Physics Education Research Section)*, **76** (1), 79-91.

Adoption-Invention Continuum:

Possible Relationships Between Researchers and Faculty



Example – Peer Instruction (Mazur, 1997)

Basic Idea: Students are asked to respond to short conceptual questions during lecture to increase engagement.

Essential Features:

- Reading assignment or quiz before lecture.
- Conceptual tests (CTs) are used to segment lecture.
- Peer-peer discussion of CTs.
- Conceptual questions on exams.

Details:

- Flash card or PRS system for managing student responses.
- Specific concept tests, reading quizzes, and exam questions
- How students are graded
- Ordering of content, etc.

Example – Peer Instruction

Adoption: Use "as is" (maybe change some details)

- Take Mazur's book, follow recommendations and use available materials.

Adaptation: Change some details to suit individual situation

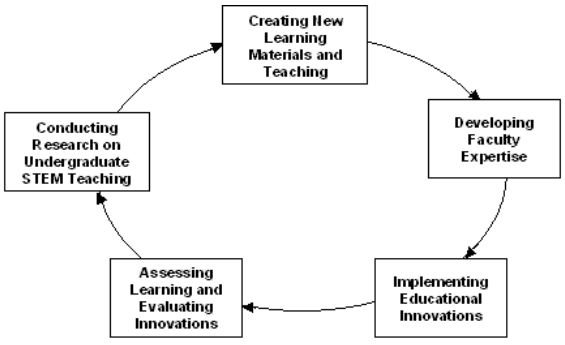
- Instead of multiple choice CTs, use free response questions.

Reinvention: Take basic idea, but drastically change or eliminate at least one essential feature

- Have one CT at end of class
- Eliminate student-student discussion

Invention: Do something completely different

Researchers Expect Adoption/Adaptation



Cyclic model for knowledge production and improvement of practice in undergraduate STEM education

From 2005 NSF-CCLI Solicitation

Faculty and Researcher Interactions

Faculty aware of Problems and Solutions

- Researchers and faculty agree on problems
  - e.g., All five faculty stated (without prompting) that traditional lecture is largely ineffective.
- Faculty aware of many possible solutions
  - Knew names and basic practices of many research-based curricula.

Researchers and Faculty Agree on Problems

Instructional Problem	Instructors T	H	M	G	B
Students don't get much from traditional lecture.	■	■	■	■	■
Different kinds of students learn differently.	■			■	■
Students have misconceptions that are not simple to change.	■	■		■	
Many students have poor problem solving skills		■	■	■	
Assessment difficulties – getting the right answer does not mean that a student understands			■		■
It is helpful to tailor explanations to individual students, but this is difficult/impossible in a large class		■			
Students have great difficulty learning the basic concepts of physics		■			

Describes Details | Describes Existence

Faculty Aware of Research-Based Solutions

Potential Solution	Instructors T	H	M	G	B
Peer Instruction	■	■	■	■	■
Physlets	■		■		■
CUPS/CUPLE	▫				
Washington Tutorials	■	■			
Workshop Physics	■	■			▫
Real-Time Physics and Interactive Lecture Demonstrations	■				
"Army" method. Pose question, pause, call on student.				■	
Have students write down answer after posing a question.				▫	
Discussion-based teaching techniques				▫	
FCI/CSEM as an assessment instrument	■	■	■		
Modeling/discussing expert thinking related to problem solving			■		
Individual interviews with each student – motivational			▫		
White boards to encourage students to interact during class.			■		
Problem solving framework.		▫	▫		
Small group work		■	■		■
Physics by Inquiry		■			
Scale-UP					■
Matter and Interactions					▫
Personal response systems			▫		▫

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Adoption | aDaptation | Reinvention | Invention

Faculty Engage in Reinvention and Invention

Instructional Strategy	Instructors T	H	M	G	B
Peer Instruction	R	R	R	R	R
Physlets	D				D
"Army" method. Pose question, pause, call on student				R	
Discussion-based teaching techniques				R	
"Exercises" to guide students through solving a problem				I	
Different instruction for different student abilities				I	
FCI/CSEM as an assessment instrument	A	A	A		
Modeling/discussing expert thinking about problem solving			R		
Small group work		R	R		D
Solicits questions from students		I			
Lecture-based questions					I

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Why Reinvention?

Faculty do not believe an externally developed curricula can match their unique style, preferences, skills, and teaching situation

-***"I do think that every teacher has to develop her style that's based on who she is, or he is." (Terry)***

- "*I mean a lot of things I won't even bother trying because I know I'm not the right person to do it*."
(Harry)

Divergent Expectations → Problems

- From Faculty Perspective
  - Each researcher is selling a particular curricula and not interested in them or their students
  - Researchers do not recognize/value faculty skill and experience
- From Researcher Perspective
  - Faculty are not interested in our work and, thus, must not care about teaching
  - Faculty inappropriately modify our curricula

What do Faculty Want?

- **Researchers and faculty work together**
  - *"I've spent my life doing this* [teaching] *and part of my teaching is in fact to be aware of all of the things that are going on, but I want it to be useful and meaningful to that discourse.*" (Terry)
- **Researchers to develop more theory than packaged curricula**
  - *"I have a good feel for the conditions under which [optical phenomena] occurs . . .I don't have an intellectual framework around which to organize innovations in teaching. . . . If I had a framework like that then I could answer my own questions [about teaching].*" (Harry)
- **Researchers to communicate openly/honestly**
  - "*It's really frustrating if somebody just falls behind a smokescreen and will start using jargon and will start talking about papers that you don't know what's in the paper*." (Mary)

Example of Dissemination Based on Reinvention/Invention:

The Modeling Physics Project

http://modeling.asu.edu/

- "Modeling" is the most successful reform effort in physics education
- Interviews with five leaders of the modeling project.
- Preliminary result:
  - Dissemination effort focused on community building.
  - Reinvention/Invention not Adoption /Adaptation

See: Dancy, M, Brewe, E. & Henderson, C., Modeling Success: Building Community for Reform. (Proceedings of the Physics Education Research Conference, 2007)

Dissemination as Community Building

- *"Here is an important thing about the modeling program, it is the building of the community and the treatment of the dignity of the members of the community that is so important…"* - Project Leader
- Community based curriculum development (wiki)
- Community based dissemination
  - "Modelers" take leadership roles in dissemination
  - Listserve for community support
  - Project initiators keep low profile

Implications

- Faculty need to be part of the instructional change process if it is to be successful. They currently feel excluded.
- Researchers should explore ways to move away from transmissionist professional development (adoption/adaption model) and towards constructivist professional development (working with faculty in informed invention).

Recommendations

- Provide easily modifiable materials.
- Disseminate and research ideas in addition to curriculum.
- Explicitly research the conditions for transfer.
- View faculty as partners.
- Acknowledge that change is difficult and support, rather than blame instructors.