Creating Lasting Reform: Diffusion of Educational Innovations via Co-Teaching

AAPT Summer Meeting
July 24, 2006
Syracuse, NY

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Overview

- Barriers to instructional change
- Co-Teaching as a promising model
- Results of a co-teaching experience

Barrier #1: Standard Dissemination Models

- Transmissionist methods not suitable for promoting fundamental changes.
- Expensive - $10,600 per self-reported change in teaching methods*.
- Have not produced widespread change†.

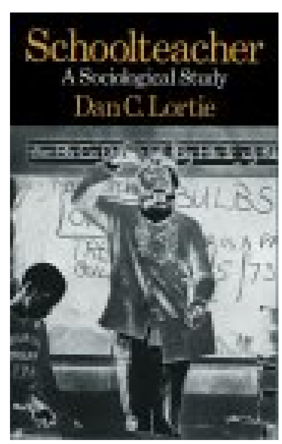
Attendees at Fall 2002 meeting of the NY State Section of the American Association of Physics Teachers at Binghamton University.

*Marder et. al., 2001; †e.g. Seymour, E. (2001).

Barrier #2: Teaching is Complex

Like any complex task, much of a teacher's decision-making is implicit and based on experience.

Faculty often do not understand the principles and details of new instruction – thus leading to non use or inappropriate modifications*.

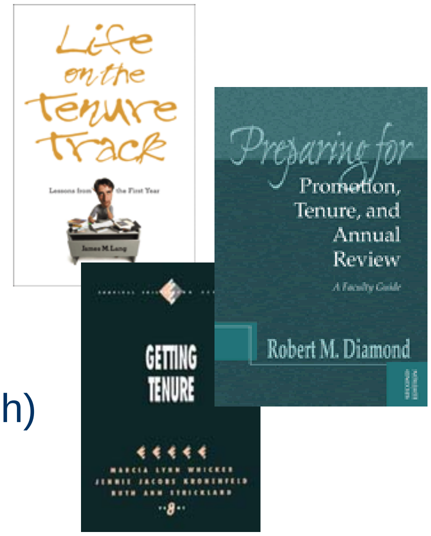


Dan Lortie (1975) – Teachers learn to teach through the *Apprenticeship of Observation*

* e.g., Spillane (2004); Henderson and Dancy (2005a)

Barrier #3: Instructional Change Can Be Dangerous

- Especially for untenured faculty*
  - May lead to lower student evaluations (at least initially)
  - May require more time than traditional instruction (thus, allowing less time for research)



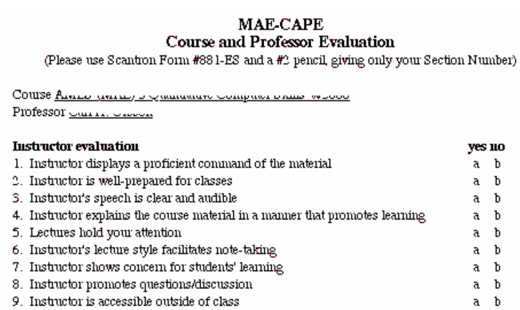
Most junior faculty are very concerned about getting tenure.

*e.g. Seymour, E. (2001).

Barrier #4: Situational Factors

Institutions are set up for traditional instruction*

Physical Infrastructure



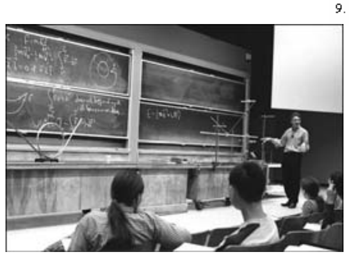
MAE-CAPE
Course and Professor Evaluation
(Please use Scantron Form #881-ES and a #2 pencil, giving only your Section Number)

Course
Professor

Instructor evaluation	yes	no
1. Instructor displays a proficient command of the material	a	b
2. Instructor is well-prepared for classes	a	b
3. Instructor's speech is clear and audible	a	b
4. Instructor explains the course material in a manner that promotes learning	a	b
5. Lectures hold your attention	a	b
6. Instructor's lecture style facilitates note-taking	a	b
7. Instructor shows concern for students' learning	a	b
8. Instructor promotes questions/discussion	a	b
9. Instructor is accessible outside of class	a	b

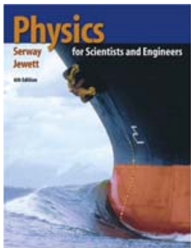
Institutional Expectations

Departmental Norms

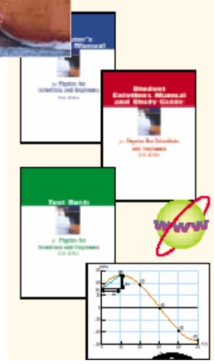


*Dancy and Henderson (2005)

Barrier #4: Situational Factors - cont



Content Coverage Expectations



Instructor's Solutions Manual

Student Solutions Manual and Study Guide

Test Bank

Web site to accompany *Physics for Scientists and Engineers, Sixth Edition* at http://www.pse6.com

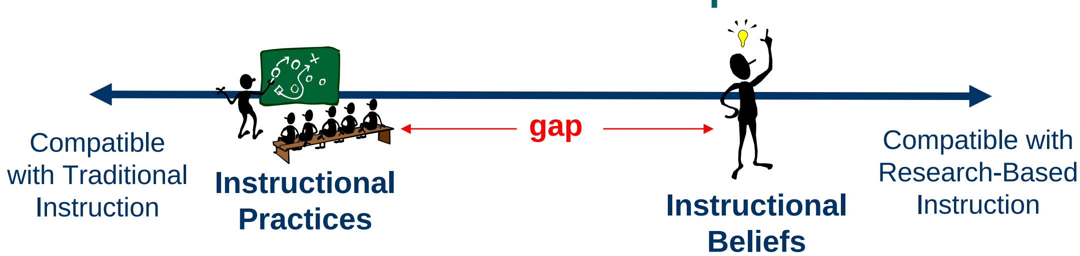
Transparency Acetates

Resource Availability

Student Expectations – the *hidden contract*

Opportunity: Faculty Beliefs and Values

Traditional Practices : PER-Compatible Beliefs



Many faculty have instructional goals and beliefs about teaching and learning that are more compatible with the results of educational research than with traditional instruction*.

*Henderson and Dancy (2005b), Yerushalmi et. al. (accepted)

Co-Teaching: Who?

CH: Experienced faculty member in WMU PhysTEC courses, experienced PER researcher with knowledge about many PER instructional interventions, co-teaching participant

MF: New faculty member in WMU Physics Dept., all prior teaching experience as a TA, some familiarity with PER via. grad study at OSU, co-teaching participant

AB: Faculty member in college of education, experience evaluating instructional changes in college faculty, outside observer of co-teaching

Co-Teaching: Why?

Goal: Enculturate MF into PhysTEC teaching

- Help MF understand how and why PhysTEC courses work through direct experience – and to see that it does work.
- Reduce the risks of instructional experimentation by working with an experienced instructor.
- Help MF develop a repertoire of materials and strategies that can be used in subsequent PhysTEC-style courses.

Co-Teaching*: What?

- Fall 2005: CH and MF co-taught Phys 2050: Introductory Calculus-Based Mechanics
  - CH and MF alternate being in charge of class each week
  - Weekly meetings between CH and MF to reflect on previous week and discuss initial plans for coming week
  - Course structure set up by CH to support PhysTEC design principles
  - MF had access to materials used by CH in previous semesters
- Spring 2006: MF teaches Phys 2050 on his own
- Data Collected
  - Individual interviews (conducted by AB) with CH and MF at beginning, middle, end of semester.
  - Teaching observations (conducted by AB) of CH and MF at beginning, middle, end of semester.

* More info about co-teaching in K-12 settings is available in Roth and Tobin (2002).

Design Principles of WMU PhysTEC Courses

(Departures from traditional instruction)

1. **Students should be actively engaged with the material during class time. This is best accomplished via student-student interaction.**
2. **Students should read the text before coming to class and most will not do this unless there is some external incentive.**
3. **Class discussions and tests should place significant emphasis on conceptual issues and qualitative questions.**
4. **Class discussions and tests should place significant emphasis on the solving of multi-step problems (i.e., ones that cannot be solved by substituting numbers into a single equation).**
5. **Student problem solutions should start from basic principles and contain written explanation of reasoning.**
6. **Test questions should require students to engage in the desired thinking processes. This means that test questions should not be similar enough to questions students have previously seen that a rote strategy is fruitful.**
7. **Formative assessment, both informal and formal, should be used to determine students' current understanding for the purpose of designing appropriate subsequent instruction.**
8. **Depth of student understanding should be valued more than breadth of content covered during the course.**

Results: MF Instructional Practices

- Observed instructional practices were consistent with PhysTEC principles from the start
  - Few differences observed between MF and CH
- MF instruction likely would have been more traditional without co-teaching:
  - "*I probably wouldn't do as many in-class activities as we are doing now. . . . and so it will probably be a little bit more like the formal lecture*." (F1#228-233)

Results: MF Beliefs

- Initial Beliefs: Skeptical
  - "*When I first came I was skeptical about having students do nothing but problems in class. Just sort of standing by while they do problems*." (F2#84-87)
- Mid-term Beliefs: Some parts are OK
  - "*It taught me something that I am going to adopt aspects of in future courses. You know, pick up the things that I think are working really well and the interactive and the discussions, things that are really useful*." (F2#194-198)
- End of term Beliefs: It is working very well
  - "*My class is going to be very similar to what we did last semester, even the structure will be the same structure. It's going to be almost identical*." (F3#272-273)

Results: Course Comparisons

	CH and MF Co-Teaching (Fall 2005)	MF (Spring 2006)
Reading Text	Students submit reading question via WebCT. (Weekly)	Reading quiz via WebCT. (Weekly)
Use of class time	Short lectures (5-10 minutes). Students spend most time working in assigned groups (usually with white boards). Tasks ranged from conceptual questions to quantitative problems.	
Assignment of groups	Students are assigned to groups of 3-4 based on where they live (as homogeneous as possible) and their performance in the prerequisite math course and FCI pretest (as heterogeneous as possible).	
Online Exercises	6-12 conceptually-oriented questions (often multiple-choice) or relatively simple calculations. (Weekly)	Used many exercises as part of reading quiz.
Student Solution	Students required to include General Approach, Procedure, Implementation in problem solutions. This was modeled by instructor during class.	Student solutions were expected to start from basic principles and show reasoning. Fall 2005 framework was modeled by instructor during class.
Homework Problems	4 problems each week. Multiple steps and specifically chosen to not be easily solvable by rote. Each student was responsible for submitting a numerical answer online (different numbers). Each group was responsible for turning in a written solution.	6-10 problems each week. Each student was responsible for turning in a written solution. Problems were similar (or identical) to Fall 2005 problems.
Use of Main Ideas	The important physics concepts were broken into 21 main ideas that were referred to in class and provided to on exams. Student problem solutions were expected to be based on one or more main idea.	
Testing	Each quiz and exam had 2-4 conceptually-oriented short answer questions and one multi-step quantitative problem. Complete written solutions were available shortly after each. (Weekly)	
Quiz Corrections	Students had option to reflect on graded quiz in order to increase score.	Not used

Results: Course Comparisons
Contribution of course components to the course grade.

Component	Co-Teaching (Fall 2005)	MF (Spring 2006)
Exam Average	**40%** (4 exams)	**30%** (3 exams)
Final Exam (comprehensive)	**20%**	**20%**
Quiz Average	**15%**	**15%**
Online Problems	**5%**	
Written Problems	**5%** (group)	**20%** (individual)
Online Exercises	**5%**	
Reading Assignment	**5%** (reading questions)	**10%** (reading quiz)
In-Class Group Work (all members get same score)	**5%**	**5%**
	100%	**100%**

Conclusions

1. It worked!
   - **Significant changes documented in beliefs and intentions.**
2. Course structure was important.
   - **Practices started out in PhysTEC mode and did not change. This was likely due to course structure that constrained possibilities.**
3. Affordable
   - **Cost $2,800 to hire a part-time instructor to cover 1 class.**
4. The entire semester was necessary
   - **Although practices did not change, beliefs and intentions continued to change throughout the semester.**
5. Co-teaching was important
   - **Not student-teacher or mentor-mentee, but collegial relationship.** "*Well the thing that I liked the most about this is it wasn't like I was Charles' protégé. He recognizes me as a colleague and we were teaching this class together. . . . it wasn't like teacher-apprenticeship which at this level it might seem sort of insulting*." (F3#283-286)

Implications

- Co-teaching is a cost-effective model that shows significant promise as a way to promote research-consistent instruction in new faculty.
- It may also be an applicable for graduate students or experienced faculty.
- Limitations
  - MF began co-teaching with neutral to favorable views of research-compatible instructional practices. It is not clear that this model would be successful with a co-teacher hostile to new methods.
  - Co-teaching only works when there is a teacher available who teaches in a research-consistent manner.
  - This is a single case -- clearly more work is needed.

References

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