Research Themes in Physics-Teacher Preparation

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Research vs. Practice

- Efforts to improve teacher preparation are treated as practical problems incorporating "art and design"
- Focus is on overall program change, not on close examination of individual program elements

“Practical” Approach to Course and Program Development

- Multiple elements of courses or programs are simultaneously introduced or revised
  - Revisions tend to be ongoing, and mutually influencing
- Documentation of changes in practice or outcomes is not often a focus

Some Important Distinctions

- Prospective ("preservice") vs. Practicing ("inservice") teachers
- Research on preparation of "science" teachers vs. preparation of "physics" teachers
- Preparation of *elementary* teachers vs. preparation of *high-school* teachers
- Research *outside* U.S. vs. *inside* U.S.
- "Pre-bac" vs. "post-bac" preservice teachers

Assessment of Pedagogical Content Knowledge (Shulman, 1986)

"***Pedagogical Content Knowledge***" **(PCK):**

Interest in and knowledge of students' ideas, and appropriate instructional strategies, related to teaching *specific* science concepts

(Includes knowledge of appropriate assessment tools and curricular materials.)

Assessment of Pedagogical Content Knowledge

- No currently accepted, standard physics-PCK instruments exist
- Documentation (not assessment) of PCK by Australian researchers (e.g., Loughran, Milroy, Berry, Gunstone, and Mulhall (2001); Loughran, Mulhall, and Berry, JRST, 2004)

Other Work on Physics PCK

Halim and Meerah (Malaysia, 2002); Berg and Brouwer (Canada, 1991)

- Teachers asked to provide predictions of how students would answer questions
- Some teachers were not aware of students' ideas, gave incorrect predictions of students' responses, and underestimated popularity of alternative conceptions

Related Work: Galili and Lehavi (Israel, 2006); Sperandeo-Mineo, Fazio, and Tarantino (Italy, 2005)

Teacher Preparation Programs with Explicit Focus on PCK

Etkina (2005): Six core physics course with emphasis on PCK

Wittmann and Thompson (2008): Analysis and discussion of curricular materials and related research papers

Inservice Workshops: Early History

- Summer workshops for inservice physics teachers began in the 1940s
- Rapid expansion in funding beginning in 1956
- PSSC curriculum developed and disseminated beginning in 1958-1960

Finlay (1962)

- Most users felt PSSC was pitched at an appropriate level, a minority felt it was too advanced.

French (1986)

- Over 100,000 students using PSSC by late 1960s.

Maxwell (1967)

- Average of 23 physics institutes per year about 1/3 PSSC

Heller, Hobbie, and Jones (1986)

NSF Summer in-service workshop in Minnesota; "Participants enjoyed and valued it"

Lippert, Heller, Jones, and Hobbie (1988)

Follow-up to previous study; "Dramatic shift away from heavy lecturing"

Nanes and Jewett (1994)

Four-week summer inservice institutes; normalized gain on content tests 40-73%

University of Washington Teacher Preparation Program…

Arons (1972, 1976)

Inquiry-based course for preservice and inservice teachers

McDermott (1974)

Course for preservice elementary and secondary teachers

McDermott (1975)

Recommendations for high-school physics teachers

McDermott (1990)

Need for special science courses for teachers; description of pre-service secondary program

McDermott (2006)

Review and reflections of 30 years of experience in teacher preparation

McDermott, Heron, Shaffer, and Stetzer (2006)

Document dramatic learning gains of preservice teachers and 9th-grade students following use of *Physics by Inquiry* (PbI).

Oberem and Jasien (2004)

- Summer inservice course for high-school teachers using *Physics by Inquiry*
- High normalized gain on conceptual questions
- Delayed gain, six to eight months later: 60-90% of original gain

Huffman, Goldberg, and Michlin (2003); Huffman (2007)

- Evaluations of “Constructing Physics Understanding” (CPU) Project
- 100-hr workshops
- Significantly higher FCI scores in teachers’ classes compared to traditional class

Hestenes, Wells, and Swackhamer (1992); Wells, Hestenes, and Swackhamer (1995); Hake (1998)

- Description and assessments of “Modeling Method” of instruction
- Students carry out qualitative analysis using multiple representations, group problem-solving, and inquiry-style experiments
- Much higher learning gains on FCI and MBT for high-school classes taught with Modeling method, compared to traditional; also, better performance on more traditional quantitative problems

Andrews, Oliver, and Vesenka (2003)

- Three-week summer institute in California using Modeling method; high normalized gains (0.35-0.43) for pre-service students

Vesenka (2005)

- High normalized gains after two-week workshop for in-service teachers using Modeling Instruction.

Otero, Finkelstein, McCray, and Pollock (2006)

- Report on Colorado “Learning Assistant” program, all sciences combined.
- High-performing undergraduate students employed as instructional assistants in introductory science courses
- Increased teacher recruitment
- Improved content knowledge of students in classes that use LAs

Kagan and Gaffney (2003)

- Description of new education degree program in physics department (CSU Chico)
- Substantial number of graduates (≈ 50% of traditional grad rate)

MacIsaac, Zawicki, Henry, Beery, and Falconer (2004)

- Alternative certification, post-bac Masters program in New York
- High demand for program; selective admission

Summary

- Many programmatic evaluations have been reported
- Relatively few studies of individual elements of programs or courses have been reported
- Great potential lies in future research regarding preservice physics teachers' PCK