Physics Education Research Research and the Transformation of Students into Physicists

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The physics major transform
PER can offer:

- A framework for analyzing successful aspects of your curriculum
- And for understanding why some instructional components are less successful
What is PER?

• An interdisciplinary subfield of physics
• With a journal: *Phys Rev ST: Phys Educ Res*
• Ph.D. granting departments
• A topical group of AAPT with a yearly conference
• Research focused on the learning and teaching of physics
PER Involves:

- Assessment
- Pedagogy
  - Constructing environments that support learning
- Curriculum components
  - Developing tasks that structure and scaffold reasoning…
- Detailed research on student thinking
  - Development of physics tasks, interview techniques, verbal analysis techniques…
- Alternative, modern curricula
  - Restructuring content and emphasis to integrate 20th century physics, modeling, computation
PER can offer resources:

• Ready-to-use curriculum components
  • Active physics
  • UW tutorials

• Pedagogical environments
  • Cooperative group problem solving
  • SCALE-UP

• Assessment tools and strategies
  • FCI, FMCE, BEMA, CSEM, TUG-K, Direct…
Reasons to Try PER-based Approaches

• Each student must construct knowledge inside his or her own mind.
• A scaffolded, supportive environment can make the process more efficient, less painful, and more collegial.
• Environments and tasks that support active engagement benefit both well-prepared and poorly prepared students.
Case Study:
Cooperative Group Problem Solving (Minnesota)

• Goal: teach systematic problem solving strategies
• Issue: students will use systematic strategies only if problems are truly challenging – not solvable by rote
• Issue: if problems are challenging students need help, but one TA can’t individually tutor 20 students simultaneously
• Solution: formal cooperative group structure with defined roles (drawn from psychology literature).
Group Roles

• Manager
  • Initiate planning, monitor progress, watch time, ask questions of TA if needed.

• Recorder
  • Only one pen: students must articulate ideas

• Skeptic
  • Checking, suggesting alternative approaches
Adopting and adapting

• Group role videos for TAs and students, made at NCSU

video 1 (YouTube)

http://www.youtube.com/watch?v=vgF_LmPqbOA

video 2 (YouTube)

http://www.youtube.com/watch?v=xAJKxNUbf8
History of Cooperative Group Problem-Solving at Minnesota:

- Implementation in algebra-based intro course
- Faculty observe success in algebra-based intro course, demand implementation in calculus-based intro course
- Introduced into upper-level majors courses, by faculty demand
- Introduced into graduate courses, by faculty demand
- TA training now self-sustaining; PER group not involved
Resources

• www.COMPADRE.org  PER central
  • Curriculum resources
  • *Reviews in PER* Vol 1: *Research-Based Reform of University Physics*, E.F. Redish & P. Cooney, Eds.

• *American Journal of Physics*
  • Articles of general interest

• AAPT National Meetings
  • PER Conference at summer meeting

• Various PER group websites

• *Phys Rev ST: Phys Educ Res*
  • Technical research articles
Current NCSU Projects

- How students read / process worked examples and incorrect solutions
- Students' use of mental models in reasoning about correct / incorrect examples
- Stimulating sense-making in computational activities
- Students use of macro/micro connections in explanations of processes
- When do expert TAs intervene, and how do they encourage sensemaking
- NCSU PER group lab facilities