NC STATE UNIVERSITY

Physics Education Research and the Transformation of Students into Physicists

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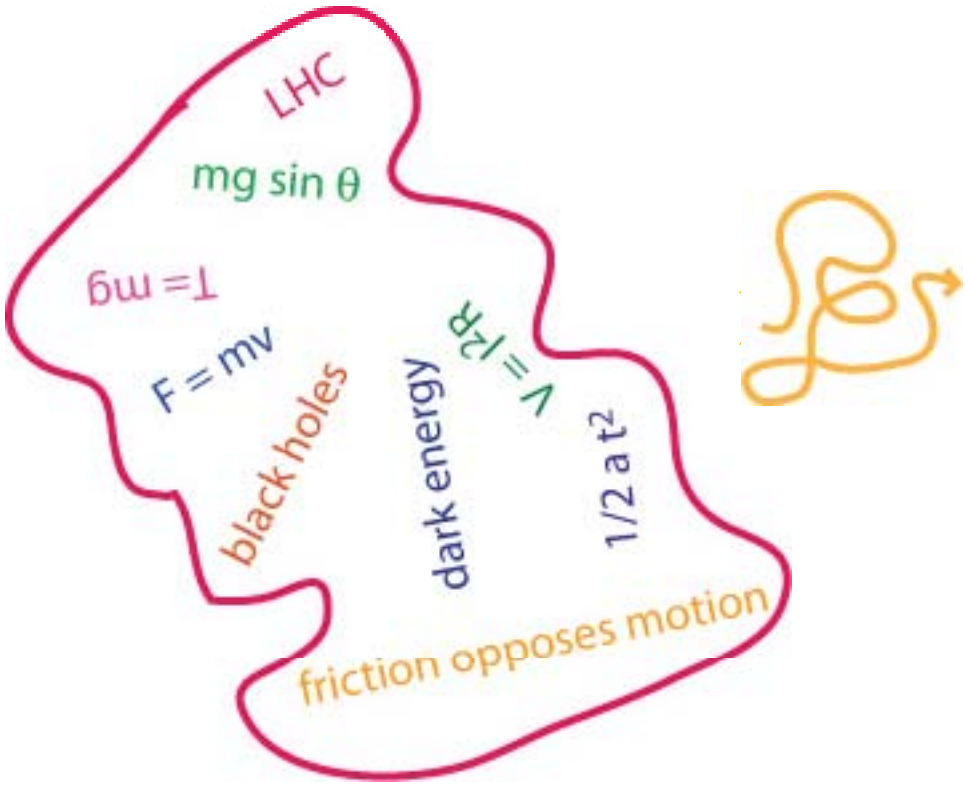
The physics major transform



Logical Reasoning
Connected formal and qualitative knowledge
Physical intuition
Systematic approach to problem solving
Principle-based arguments
Experimental skills
Computational skills
Knowledge of current physics research areas
Excitement about physics!

initial state

final state

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=xAJKxNUbjf8

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 activites
- 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