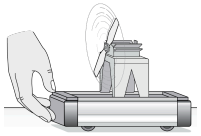

Development and evaluation of a large-enrollment, active-learning physical science curriculum

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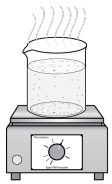
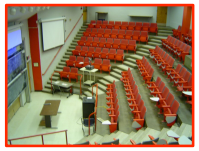


Learning Physical Science (LEPS)

A new guided inquiry, physical science curriculum
Conceptual themes of energy, forces, and the atomic-molecular theory of matter
Includes an explicit focus on nature of science and the nature of learning
Is suitable for a large lecture hall environment
Was adapted from Physical Science & Everyday Thinking (PSET) [1]
Developed through iterative pilot- and field-testing, feedback, and revision

Adapting PSET to LEPS



PSET used research-based learning principles and assumed small classes with:
- students engaged in hands-on experimentation
- small group work and discussion
- whole class discussions
- ~75 hours of class meeting time.

LEPS was designed with the same learning principles, but for courses with
- large enrollments
- traditional lecture hall classrooms
- ~45 hours of class time
- technology to assist collaboration and interactive engagement

Design objectives guiding the adaption of LEPS from PSET:
- Provide opportunities for students to learn content, the nature of science, and to reflect on their own learning
- Follow the learning principles of PSET
- Use existing, proven instructional techniques for large enrollment classes (such as Peer Instruction) when appropriate
- Develop a standard structure for class activities and homework
- Provide sufficient flexibility for use in different institutional contexts
- Provide instructors with tools to guide their classroom implementation

Feature	PSET	LEPS
Class activity/ setting	Small group & whole class discussion	Near neighbor discussion and electronic polling
Source of evidence	Hands-on experiments and simulations in small groups	Videos of experiments and simulations
Scope of lesson	60-120 min, several ideas	25 min, single idea
Consensus	End of unit	End of lesson
HW	Paper/pencil	Online
Lab	Embedded	Optional

Acknowledgements
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References

1. F. Goldberg, S. Robinson, R. Kruse, N. Thompson, and V. Otero, *Physical Science and Everyday Thinking*, It's About Time: Armonk, NY, 2007.
2. W. Adams, et al., *Phys. Rev. ST Phys. Educ. Res.* **2**, 010101 2006.

LEPS: In-class lessons and online homework

During ~25 min lessons (2-3 lessons per class meeting):
- Instructor guides class using PowerPoint slides
- Class time is spent on 'clicker' questions; videos of experiments and simulations; making sense and summarizing questions
- Students fill in the data tables and answer questions in lesson sheets
- Certain lessons focus on nature of learning (NOL) or nature of science (NOS)

Lessons consist of
1) Purpose and Key Questions: the lesson's rationale and focus
2) Predictions, Observations, and Making Sense including:
- Initial question to elicits students' prior knowledge
- Videos of demonstrations, experiments or simulations provide evidence
- Students record observations and answer guiding questions
- Occasional narrative text/diagrams introduce new terms or descriptions

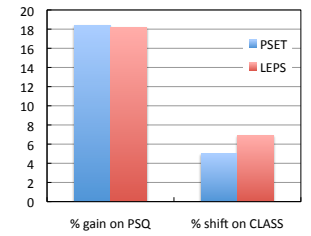
3) Summarizing Questions: 1-2 questions to see if students synthesized the main ideas

Most lessons have an online **homework** assignment consisting of:
- Narrative text, diagrams, etc.
- Videos of demonstrations, experiments or simulations, or actual simulations
- Questions (not graded) with feedback
- A graded quiz at the end of the homework

Homework is compatible with a learning management system (LMS).

Outcomes

Content learning goals were assessed with a 28 item, multiple-choice, physics and chemistry assessment (Physical Science Questionnaire, or PSQ)
The Colorado Learning Attitudes About Science Survey (CLASS) [2] was used to gather information on students' views about science and learning.
In Fall '09 and Spring '10, the PSQ and CLASS were administered as voluntary on-line pre- and post-assessments in 10 LEPS classes (avg enrollment 68) and 17 PSET classes (avg enrollment 29).



No significant difference between LEPS and PSET average course PSQ or CLASS gains (two-tailed t-tests: **PSQ** t(25)=0.94, p=0.35; **CLASS** t(25)=0.29, p=0.78)

Conclusions

LEPS shares PSET's core learning principles but with a different course format.
Students in LEPS and PSET courses make similar gains in content and views about science (as assessed by PSQ and CLASS). However, other aspects of student performance (eg, scientific discourse skills) were not assessed.
Given the resource constraints faced by many universities, we believe LEPS is a valuable alternative to a lecture-based large enrollment course.