Development and Evaluation of a Large-Enrollment, Active-Learning Physics Curriculum

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Learning Physics (LEP)

LEP is a new guided inquiry, conceptual physics curriculum suitable for large classes. LEP is one of a family of related curricula: *Learning Physical Science* (LEPS) [1, 2], *Physical Science & Everyday Thinking* (PSET), & *Physics & Everyday Thinking* (PET) [3]. Conceptual themes include conservation of energy and Newton's laws, light, magnetism, and electricity.

In LEP, students:

- Watch videos of experiments/sims
- Do hands-on work in small groups
- Answer open-ended prompts to make predictions, make sense of observations, and interpret representations
- Develop and use models
- Engage in small group discussions
- Support claims with evidence & reasoning
- Write and evaluate explanations using a structured, web-based system

Hands-on Activities in LEP

During ~half the course, groups do hands-on experiments and simulations. Remaining class time is spent on instructor-guided lessons featuring videos of demonstrations, peer discussion, and "clicker" questions, similar to LEPS [1, 2]

Writing and Evaluating Explanations

LEP includes 5 *Calibrated Peer Review* (CPR) tasks, which include 3 stages:
Text submission: Students explore background material and submit text and image.
Calibration: Students rate "calibration" essays prepared by the curriculum developers.
Peer review: Students evaluate the work of several classmates and their own work.

CPR provides structure and feedback for students to learn how to construct and evaluate explanations, but without an unreasonable grading load on the instructor.

LEP content and pedagogical format.
IG = Instructor guided; SGHO = small group hands-on.

Unit	Title	Pedagogy
1	Interactions and Energy	IG
2	A Model for Magnetism	SGHO
3	A Model for Static Electricity	SGHO
4	Interactions & Potential Energy	IG
5	Interactions & Forces	IG
6	Light Interactions	SGHO
7	Electric Circuit Interactions	SGHO

Acknowledgements

The authors would like to acknowledge Melissa Dancy, participating PET instructors, CSUSM IITS, and NSF DUE grants 0717791 & 1044172.

References

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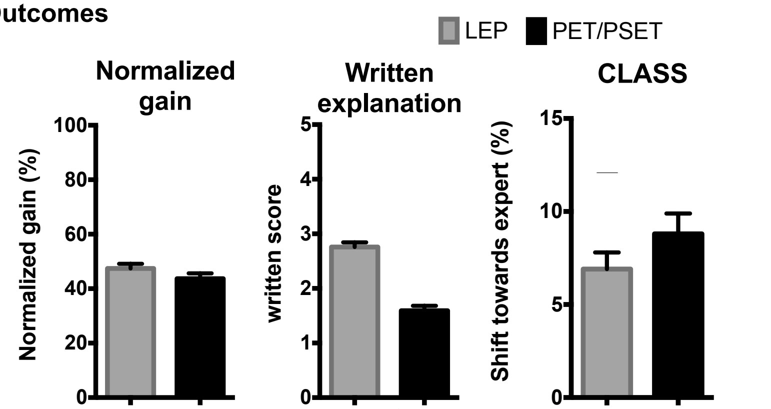
Evaluation

Content learning Pre/post assessment with a 12-item, multiple-choice conceptual instrument in both LEP and PET classes

Written explanations A final exam question asking for diagrams and a written narrative was given in LEP and PET classes. The question concerned Newton's Second Law; LEP and PET each spend a unit on forces and motion. A 5-point rubric was used for scoring students' responses. Two raters scored all responses and interrater reliability was 90%.

Views about science and learning science Pre/post assessment with the Colorado Learning Attitudes About Science Survey (CLASS) [4] in LEP classes.

Outcomes



(Left) Content assessment average percentage normalized gain for LEP (N=326) and PET (N=309) students. Error bars are SEM. p= 0.15; t=1.456 df=633.

(Center) Average post test explanation question performance for LEP (N=334) and PET (N=324) students. Error bars are SEM. p<0.0001.

(Right) Average shift towards expert-like views on CLASS survey for LEP (N=259) and PET/PSET (N=368) students as reported by Otero and Gray [5]. Error bars are SEM. p= 0.21; t=1.258 df=625.

Conclusions

LEP = lecture hall environments, classes of 60-100 students, some hands-on exploration of phenomena, & support for constructing scientific explanations.

LEP students learned significant physics content, developed more expert-like views about science and learning, performed comparably to PET students on a conceptual content assessment, and the CLASS survey, and outperformed PET students on an end-of-semester written explanation.