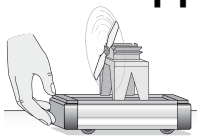
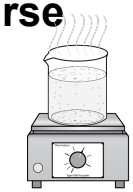
Supporting scientific writing and evaluation in a conceptual physics course with Calibrated Peer Review



Edward Price[1], Fred Goldberg[2], Scott Patterson[2], and Paul Heft[1]

[1]CSU San Marcos; [2]San Diego State University



Learning Physics (LEP)

LEP is a new guided inquiry, conceptual physics curriculum suitable for large classes. LEP is adapted from the *Physics and Everyday Thinking* (PET) [1] and Learning Physical Science (LEPS) curricula [2].

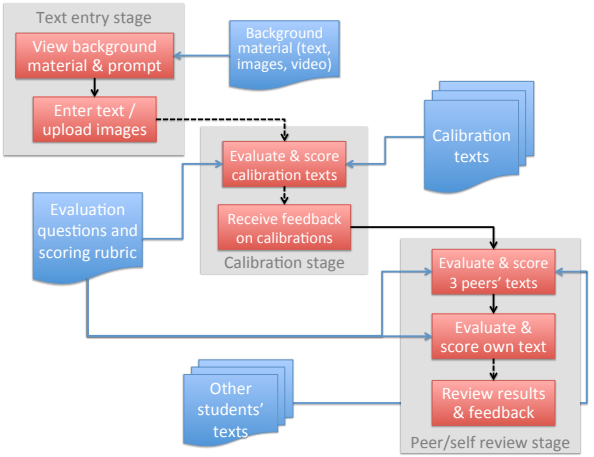
Conceptual themes include conservation of energy and Newton's laws, light, magnetism, and electricity. LEP includes a focus on scientific practices and the nature of science.

Writing and evaluating explanations are important scientific practices, and significant components of PET. *How can we meaningfully include this in a large class without imposing a large burden on instructors?* In LEP, students construct and evaluate explanations via the Calibrated Peer Review (CPR) system developed at UCLA [3].

Research question: *What is the validity of the peer evaluation process in CPR?*

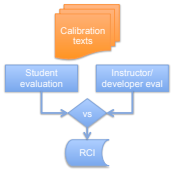
Calibrated Peer Review

CPR is a web-based tool to support students' construction and evaluation of explanations. CPR uses peer review with a training component to prepare students for reviewing.



Reviewer Competency Index (RCI)

CPR measures a student's competence as a reviewer with RCI, an integer from 0-6.
RCI is based on the degree of agreement with developer's evaluation and score of calibration texts.
Peer evaluations are weighted based on the reviewer's RCI, leading to average weighted text rating (AWTR), which is CPR's best evaluation of a student's text.



Acknowledgements

The authors would like to acknowledge Mike McKean, Melissa Dancy, CSUSM's IITS, and NSF DUE grants 0717791 and 1044172

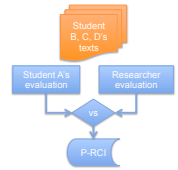
CPR Tasks in LEP

Unit 1 (U1) Task Students construct energy transfer diagrams for a chain of interacting objects and determine the energy efficiency.
Unit 4 (U4) Task Students use an alignment model of magnetism to explain a nail being magnetized by a magnet, and demagnetized after being hit with a hammer.
A full description of the magnetism task is available at
http://faculty.csusm.edu/price/LEP/CPR_example.html

Evaluation questions: 10 yes/no questions, designed to be specific and unambiguous, e.g., "Does the first paragraph correctly describe that inside the unmagnetized nail there are (many) tiny magnets that are randomly oriented; that is, their NPs (or SPs) point in different directions, or something similar?" Score is number of "yes" responses.

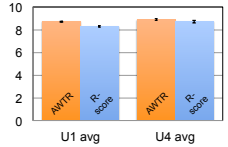
Methods

Independent scoring of students' texts using the same evaluation procedure used by their peers gives a researcher score (R-score).
Comparison of peer score with R-score gives Peer-Review Competency Index (P-RCI) in analogy with RCI.
Comparisons: R-score vs peer scores → validity of peer evaluation
P-RCI vs RCI → validity of RCI



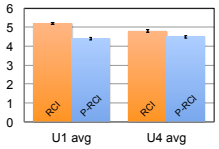
Results and Conclusions

Average AWTR is greater than average R-score for both tasks, but only statistically significant for U1.
Correlation between AWTR and R-score gives $R^2 = 0.67$ for U1, and $R^2 = 0.68$ for U4 (Pearson linear test, $p<0.001$ for both).

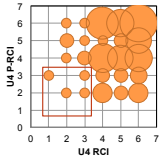


→ Based on the degree of correlation and small difference between averages for the R-score and AWTR, CPR's peer-reviewing process leads to valid AWTR scores for most students.
→ Difference between average AWTR and average R-score is smaller for U4 than U1. This could be evidence for improvement in students' ability to write and evaluate explanations. However, an increased familiarity with the CPR system and level of understanding of the unit content could also be factors.

Average RCI score is greater than average P-RCI score for both tasks, but only statistically significant for U1.
For U4 Task, 18% students had high RCI but low P-RCI.



→ P-RCI and RCI might differ because student essays differ from the calibration essays, students treat the two tasks differently, or students learn during the calibration and/or peer reviewing process



References

(1) F. Goldberg, E. Price, S. Robinson, D. Boyd-Harlow, and M. McKean. *Phys. Rev. ST Phys. Educ. Res.* **8**, 010121, 2012.
(2) Goldberg, F., Robinson, S., and Otero, V. Physics and Everyday Thinking. It's About Time, Mount Kisco, NY (2008)
(3) http://cpr.molsci.ucla.edu/Home.aspx