

References

- ¹ S. J. Pollock and N. D. Finkelstein, "Impacts of Curricular Change: Implications from 8 Years of Data in Introductory Physics," *PERC Proceedings 2012*, (submitted).
- ² C. Henderson, N. Finkelstein, and A. Beach, "Beyond Dissemination in College science teaching: An Introduction to Four Core Change Strategies," *Journal of College Science Teaching* **39** (5), 18-25 (2010).
- ³ J. F. Volkwein, L. R. Lattuca, B. J. Harper, and R. J. Domingo, "Measuring the Impact of Professional Accreditation on Student Experiences and Learning Outcomes," *Research in Higher Education* **48** (2), 251-282 (2007).
- ⁴ <http://perusersguide.org>
- ⁵ <http://compadre.org>
- ⁶ C. Henderson, N. Finkelstein, and A. Beach, "Beyond Dissemination in College science teaching: An Introduction to Four Core Change Strategies," *Journal of College Science Teaching* **39** (5), 18-25 (2010).
- ⁷ <http://phet.colorado.edu>
- ⁸ W. K. Adams, S. Reid, R. LeMaster, S. B. McKagan, K. K. Perkins, and C. E. Wieman, "A Study of Educational Simulations Part I - Engagement and Learning," *Journal of Interactive Learning and Research* **19**, 397(2008); W. K. Adams, S. Reid, R. LeMaster, S. B. McKagan, K. K. Perkins, and C. E. Wieman, "A Study of Educational Simulations Part II - Interface Design," *Journal of Interactive Learning and Research* **19**, 551 (2008).
- <http://phet.colorado.edu/web-pages/publications/PhET%20interview%20Paper%20Part%20I.pdf>
<http://phet.colorado.edu/web-pages/publications/PhET%20interview%20Paper%20Part%20II.pdf>
- ⁹ User testing research from the PhET Interactive Science Simulations team suggests that 4-6 interview participants are sufficient to assess the usability of a web-based resource. See Ref. 8.
- ¹⁰ E. C. Sayre and A. F. Heckler, "Peaks and decays of student knowledge in an introductory E&M course," *Phys. Rev: ST PER* **5**, 013101 (2009).
- ¹¹ A. F. Heckler and E. C. Sayre, "What happens between pre- and post-tests: Multiple measurements of student understanding during an introductory physics course," *Am. J. Phys.* **78** (7) 768-777 (2010).
- ¹² E. C. Sayre, S. V. Franklin, J. Clark, and Y. Sun, "Learning, Retention, and Forgetting of Newton's Third Law throughout University Physics," *Phys. Rev: ST PER* **8**, 010116 (2012).
- ¹³ T. Brown and E. C. Sayre, "Changes in students' epistemologies," *PERC Proceedings 2012*, (submitted).
- ¹⁴ T. Wang, T. and E. C. Sayre, "Maximum Likelihood Estimation (MLE) of students' understanding of vector subtraction," *PERC Proceedings 2010*, AIP Press. Melville NY (2010).
- ¹⁵ C. Henderson, "Promoting Instructional Change in New Faculty: An Evaluation of the Physics and Astronomy New Faculty Workshop," *Am. J. Phys.* **76** (2), 179-187 (2008).
- ¹⁶ D. Hestenes, M. Wells, and G. Swackhamer, "Force Concept Inventory," *Phys. Teach.*, **30**, 141 (1992).
- ¹⁷ R. Beichner, "Testing student interpretation of kinematics graphs," *Am. J. Phys.* **62**, 750 (1994); R. K. Thornton and D. R. Sokoloff, "Assesing student learning of Newton's laws: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula," *Am. J. Phys.* **66**, 338 (1998); Paula Vetter Engelhardt and Robert J. Beichner, "Students understanding of direct current resistive electrical circuits," *Am. J. Phys.* **72**, 98 (2004); D. P. Maloney, T. L. O'Kuma, C. J. Hieggelke, and A. Van Heuvelen, "Surveying students' conceptual knowledge of electricity and magnetism," *Am. J. Phys.*, **69**, S12 (2001); C. Singh and D. Rosengrant, "Multiple-choice test of energy and momentum concepts," *Am. J. Phys.* **71**, 607 (2003); L. Ding, R. Chabay, B. Sherwood, and R. Beichner, "Evaluating an electricity and magnetism assessment tool: Brief electricity and magnetism assessment," *Phys. Rev: ST PER* **2**, 010105 (2006).
- ¹⁸ D. L. MacIsaac and K. A. Falconer, "Reforming physics education via RTOP," *The Physics Teacher* **40**(8), 479-485 (2001).
- ¹⁹ E. Mazur, *Peer Instruction* (Prentice Hall: Upper Saddle River, 1997); E. Mazur, "Confessions of a Converted Lecturer" <<http://bit.ly/dBYsXh>>
- ²⁰ <http://www.cwsei.ubc.ca>
- ²¹ R.R. Hake, "Interactive-engagement vs. traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," *Am. J. Phys.* **66**, 64-74 (1998).

²² <http://www.ncsu.edu/per/TestInfo.html>
<http://www.physics.umd.edu/perg/tools/diags.htm>
<http://www.flaguide.org/tools/tools.php>

²³ We have received permission from the American Modeling Teachers Association to host the Force Concept Inventory, and from the University of Colorado Science Education Initiative to host all assessment instruments developed by their program, including the Colorado Upper Division Electrostatics Assessment and the Quantum Mechanics Assessment Tool.

²⁴ C. Henderson, "The challenges of instructional change under the best of circumstances: A case study of one college physics instructor," *Am. J. Phys.* **73**, 778 (2005).

²⁵ C. Henderson and M. H. Dancy, "Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics," *Phys. Rev: ST PER* **3**, 020102 (2007); C. Henderson and M. H. Dancy, "Physics faculty and educational researchers: Divergent expectations as barriers to the diffusion of innovations," *Am. J. Phys.* **76**, 79 (2008); C. Henderson and M. H. Dancy, "Impact of physics education research on the teaching of introductory quantitative physics in the United States," *Phys. Rev: ST PER* **5**, 020107 (2009); M. H. Dancy and C. Henderson, "Pedagogical practices and instructional change of physics faculty," *Am. J. Phys.* **78**, 1056-1063 (2010).

²⁶ Association of American Universities Undergraduate Stem Education Initiative:
<http://www.aau.edu/policy/article.aspx?id=12588> (2011).

²⁷ C. Henderson and M. Dancy, *Increasing the Impact and Diffusion of STEM Education Innovations*, A White Paper commissioned for the Characterizing the Impact and Diffusion of Engineering Education Innovations Forum, New Orleans, LA, Feb 7-8, 2011. (2011); M. Dancy and C. Henderson, *Barriers and Promises in STEM Reform*, Paper commissioned for Workshop on Linking Evidence and Promising Practices in STEM Undergraduate Education, The National Academies Division of Behavioral and Social Sciences and Education. (2008).

²⁸ S. J. Pollock and N. D. Finkelstein, "Sustaining Educational Reforms in Introductory Physics," *Phys. Rev: ST PER* **4**, 010110 (2008).

²⁹ Valerie Otero, Steven Pollock & Noah Finkelstein, "A Physics Department's Role in Preparing Physics Teachers: The Colorado Learning Assistant Model," *Am. J. Phys.* **78**, 1218 (2010).

³⁰ L. McCullough and D. Meltzer, "Differences in Male/Female Response Patterns on Alternative-format Versions of the Force Concept Inventory." *2001 Physics Education Research Conference Proceedings*. Rochester, New York (2001).