

Education Articles (1979 – 2007)*†

Richard R. Hake

NOTE:

1. All URL's are hot linked. Tiny URL's are courtesy <http://tinyurl.com/create.php>.
2. The formatting is a blend of the best formatting features recommended by the AIP (American Institute of Physics), APA (American Psychological Association, and CSE (Council of Science Editors).
3. References are COLOR CODED such that those in:
 - (a) **blue text** appeared in peer-reviewed journals or books,
 - (b) **violet text** appeared in non-peer-reviewed outlets or are in preparation.

Hake R.R. & J.C. Swihart. 1979. "Diagnostic Student Computerized Evaluation of Multicomponent Courses," *Teaching and Learning* V(3), Indiana University, updated on 11/97; online at <http://www.physics.indiana.edu/~sdi/DISCOE2.pdf> > (20kB).

Hake, R.R. 1987. "Promoting Student Crossover to the Newtonian World," *Am. J. Phys.* **55**(10): 878-884; online at <http://www.physics.indiana.edu/~hake/PromotingCrossover.pdf>> (788 kB).

Tobias S. & R.R. Hake. 1988. "Professors as physics students: What can they teach us?" *Am. J. Phys.* **56**(9): 786-794, online at <http://www.physics.indiana.edu/~hake/ProfsAsStudents.pdf>> (1.1 MB).

Hake, R.R. 1991. "My Conversion To The Arons-Advocated Method Of Science Education," *Teaching Education* **3**(2): 109-111; online at <http://www.physics.indiana.edu/~hake/MyConversion.pdf>> (12 kB).

Hake, R.R. 1992. "Socratic pedagogy in the introductory physics lab," *Phys. Teach.* **30**: 546-552; updated version (4/27/98) at <http://www.physics.indiana.edu/~sdi/SocPed1.pdf>> (88 kB).

Hake, R.R. 1993. "Introducing Work," letter to the editor, *Phys. Teach.* **31**(4): 197 (1993); online to subscribers at <http://scitation.aip.org/dbt/dbt.jsp?KEY=PHTEAH&Volume=31&Issue=4>>.

*The reference is: Hake, R.R. 2007. "Education Articles (1979 – 2007)," online at <http://www.physics.indiana.edu/~hake/EdArticles1979-2007c.pdf>>. I welcome comments and suggestions addressed to rrhake@earthlink.net.

† Partially supported by NSF Grant DUE/MDR-9253965.

© Richard R. Hake, 2 July 2007.

Hake, R.R. 1994. "More on Coriolis myths and draining bathtubs," letter to the editor, *Am. J. Phys.* **62**: 1063; online at <<http://www.physics.indiana.edu/~hake/CoriolisMyths.pdf>> (112 kB). See also SDI Lab #3 Appendix: "Rotating Reference Frames," online at <<http://www.physics.indiana.edu/~sdi>>.

Halloun, I., R.R. Hake, E.P Mosca, D. Hestenes. 1995. Force Concept Inventory (Revised, 1995); online (password protected) at <<http://modeling.asu.edu/R&E/Research.html>>. Available in English, Spanish, German, Malaysian, Chinese, Finnish, French, Turkish, Swedish. and Russian.

Hake, R.R. 1997. "Evaluating Conceptual Gains in Mechanics: A six-thousand-student survey of test data," *AIP Conference Proceeding No. 399, The Changing Role of Physics Departments in Modern Universities: Proceedings of the ICUPE*, edited by E.F. Redish and J.S. Rigden, (AIP, Woodbury), p. 595-603.

Hake R.R. & R. Wakeland. 1997. " 'What's F? What's m? What's a?': A Non-Circular SDI-TST-Lab Treatment of Newton's Second Law" in *Conference on the Introductory Physics Course*, Jack Wilson, ed. Wiley. pp. 277-283. [See also SDI Lab #6 "Newton's Second Law Revisited," online at <<http://www.physics.indiana.edu/~sdi>>.]

Hake, R.R. 1998a. "Interactive-engagement vs traditional methods: A six thousand-student survey of mechanics test data for introductory physics courses," *Am. J. Phys.* **66**(1): 64-74; online at <<http://www.physics.indiana.edu/~sdi/ajpv3i.pdf>> (84 kB).

Hake, R.R. 1998b. "Interactive-engagement methods in introductory mechanics courses," online at <<http://www.physics.indiana.edu/~sdi/IEM-2b.pdf>> (108 kB) - a crucial companion paper to Hake (1998a).

Hake, R.R. 1998c. "Interactive-engagement vs Traditional Methods in Mechanics Instruction," *APS Forum on Education Newsletter*, Summer 1998, p. 5-7; online at <<http://www.physics.indiana.edu/~sdi/FOEN-1e.pdf>> (16 kB). Some criticisms of Hake (1998a, b) and of physics-education reform generally, are countered.

Hake, R.R. 1999a. "REDCUBE: REsearch, Development, and Change in Undergraduate Biology Education: A Web Guide for Non-Biologists," online at <<http://www.physics.indiana.edu/~redcube/redcube.pdf>> (377 kB). Gives non-biologists (and even biologists) a point of entry into the vast literature and web resources relevant to research, development, and change in undergraduate biology education. It contains 47 biology-educator profiles; 446 references (including 124 relevant to general science-education reform); and 490 hot-linked URL's on:

- (a) Biology Associations,
- (b) Biology Teachers Web Sites,
- (c) Scientific Societies and Projects (not confined to Biology),
- (d) Higher Education,
- (e) Cognitive Science and Psychology,
- (f) U.S. Government, and
- (g) Searches and Directories.

The references and URL's may be generally useful to teachers and education researchers, and may provide some ideas for hastening education reform.

Hake, R.R. 1999b. "What Can We Learn from the Biologists About Research, Development, and Change in Undergraduate Education?" *AAPT Announcer* **29**(4): 99 (1999); online at <<http://www.physics.indiana.edu/~hake/WhatLearn-013100g.pdf>> (204K). Page 3 shows a schematic illustrating the thus-far unrealized potential of discussion lists for promoting interdisciplinary synergy and thus hastening the glacial pace of education reform.

Hake, R.R. 2000a. "Towards Paradigm Peace in Physics Education Research," presented at the annual meeting of the American Educational Research Association, New Orleans, 24-28 April; online at <http://www.physics.indiana.edu/~sdi/AERA-Hake_11.pdf> (168 KB). Also at that location is a pdf version <<http://www.physics.indiana.edu/~hake/ParadigmSlides.pdf>> (244 kB) of the PowerPoint slides shown at the meeting.

Hake, R.R. 2000b. "The General Population's Ignorance of Science Related Societal Issues: A Challenge for the University," *AAPT Announcer* **30**(2): 105; online at <<http://www.physics.indiana.edu/~hake/GuelphSocietyG.pdf>> (2.1MB). Based on an earlier libretto with the leitmotiv: "The road to U.S. science literacy begins with effective university science courses for pre-college teachers." The opera dramatizes the fact that the failure of universities *throughout the universe* to properly educate pre-college teachers is responsible for our failure to observe any signs of either terrestrial or extraterrestrial intelligence.

Hake, R.R. 2000c. "What Can We Learn from the Physics Education Reform Effort?" ASME Mechanical Engineering Education Conference: *Drivers and Strategies of Major Program Change*, Fort Lauderdale, Florida, March 26-29; online at <<http://www.physics.indiana.edu/~hake/ASME-040300e.pdf>> (436 kB).

Hake, R.R. 2000d. "The Need for improved physics education of teachers: FCI pretest scores of graduates of high school physics courses," *Physics Education Research Conference 2000: Teacher Education*, Univ. of Guelph, August 2-3; online at <<http://www.physics.indiana.edu/~hake/PERC2000-HSTeach-5.pdf>> (929 kB).

Hake, R.R. 2000e. "Is it Finally Time to Implement Curriculum S?" *AAPT Announcer* **30**(4): 103; online at <<http://www.physics.indiana.edu/~hake/CurrS-031501.pdf>> (1.2 MB) - 400 references & footnotes, 390 hot-linked URL's. This paper concerns improving the education of undergraduate physics majors by instituting a "Curriculum S" for "Synthesis." But because that's a small part of a much larger educational problem in the U.S. there's a lot of material on the reform of P-16 education generally (P = preschool).

Mahajan, S. & R.R. Hake. 2000. "Is it time for a physics counterpart of the Benezet/Berman math experiment of the 1930's?" *Physics Education Research Conference 2000: Teacher Education* <<http://www.sci.ccny.cuny.edu/~rstein/perc2000.htm>>; online at <<http://arxiv.org/pdf/physics/0512202>>, and as ref. 6 at <<http://www.inference.phy.cam.ac.uk/sanjoy/benezet/>>. We suggest a K-12 science curriculum inspired by and compatible with the virtually forgotten pioneering work of Benezet (1935/36) [See the Benezet Centre <<http://www.inference.phy.cam.ac.uk/sanjoy/benezet/>>].

Hake, R.R. 2002a. "Lessons from the physics education reform effort," *Ecology and Society* **5**(2): 28; online at <<http://www.ecologyandsociety.org/vol5/iss2/art28/>>. Ecology and Society (formerly Conservation Ecology) is a free online "peer-reviewed journal of integrative science and fundamental policy research" with about 11,000 subscribers in about 108 countries.

Hake, R.R. 2002b. "Assessment of Student Learning in Introductory Science Courses," *2002 PKAL Roundtable on the Future: Assessment in the Service of Student Learning*, online at <<http://www.physics.indiana.edu/~hake/ASLIS.Hake.060102f.pdf>> (192 kB). At the same conference see also "Whence Do We Get the Teachers? (Response to Madison)," online at <<http://www.physics.indiana.edu/~hake/MadisonResponse-061702d.pdf>> (44kB).

Hake, R.R. 2002c. "Assessment of Physics Teaching Methods," *Proceedings of the UNESCO ASPEN Workshop on Active Learning in Physics*, Univ. of Peradeniya, Sri Lanka, 2-4 Dec.; online at <<http://www.physics.indiana.edu/~hake/Hake-SriLanka-Assessb.pdf>> (84 kB). [UNESCO = United Nations Educational, Scientific, and Cultural Organization; ASPEN = ASian Physics Education Network.]

Hake, R.R. 2002d. "Socratic Dialogue Inducing Laboratory Workshop," *Proceedings of the UNESCO-ASPEN Workshop on Active Learning in Physics*, Univ. of Peradeniya, Sri Lanka, 2-4 Dec. 2002; online at <<http://www.physics.indiana.edu/~hake/Hake-SriLanka-SDIb.pdf>> (44 kB). [UNESCO = United Nations Educational, Scientific, and Cultural Organization; ASPEN = ASian Physics Education Network.]

Hake, R.R. 2002e. "Re: Problems with Student Evaluations: Is Assessment the Remedy?" online at <<http://www.physics.indiana.edu/~hake/AssessTheRem1.pdf>> (72 kB).

Hake, R.R. 2002f. "Comment on 'How do we know if we are doing a good job in physics teaching?' by Robert Ehrlich," *Am. J. Phys.* **70**(10): 1058-1059; online at <<http://www.physics.indiana.edu/~hake/HakeOnEhrlich-2.pdf>> (40 kB).

Hake, R.R. 2002g. "Physics First: Precursor to Science/Math Literacy for All?" *APS Forum on Education Newsletter*, Summer 2002; online at <<http://www.aps.org/units/fed/newsletters/summer2002/index.html>>.

Hake, R.R. 2002h. "Physics First: Opening Battle in the War on Science/Math Illiteracy?" Submitted to the *American Journal of Physics* on 27 June 2002; online at <<http://www.physics.indiana.edu/~hake/PhysFirst-AJP-6.pdf>> (220 kB).

Hake, R.R. 2002i. "Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization," submitted to the Physics Education Research Conference; Boise, Idaho; August 2002; online at <<http://www.physics.indiana.edu/~hake/PERC2002h-Hake.pdf>> (220 KB).

Mallow, J.V. & R.R. Hake. 2002. "Gender Issues in Physics/Science Education (GIPSE) – Some Annotated References," online at <<http://www.physics.indiana.edu/~hake/GIPSE-4b.pdf>> (232kB), and at the APS website <<http://www.aps.org/educ/cswp/women-links.cfm>>, <<http://www.aps.org/programs/women/resources.cfm#swp/women-links.cfm>> under "Gender Issues." Contains about 300 references and 200 hot-linked URL's.

Hake, R.R. 2004a. "Design-Based Research: A Primer for Physics Education Researchers," submitted to the *Am. J. Phys.* on 10 June 2004; online at <<http://www.physics.indiana.edu/~hake/DBR-AJP-6.pdf>> (310kB); see especially Section II "The Insularity of Educational Research." See also Hake (2004c, 2007c)

Hake, R.R. 2004b. "The Arons Advocated Method," submitted to the *Am. J. Phys.* on 24 April 2004; online at <<http://www.physics.indiana.edu/~hake/AronsAdvMeth-8.pdf>> (144 kB).

Hake, R.R. 2004c. “ ‘Design-Based Research’: Old PER Wine in a New Bottle,” submitted on 16 July 2004 to the PERC 2004 Physics Education Research Conference, 4-5 August 2004, Sacramento, California; online at <http://www.physics.indiana.edu/~hake/PERC2004-Hake6.pdf> (120 kB). See also Hake (2004a, 2007c)

Hake, R.R. 2004d. “Direct Science Instruction Suffers a Setback in California - Or Does It?” *AAPT Announcer* **34**(2): 177; online at <http://www.physics.indiana.edu/~hake/DirInstSetback-041104f.pdf> (420 KB) [about 160 references and 180 hot-linked URL's]. A pdf version of the slides shown at the meeting is also available at <http://www.physics.indiana.edu/~hake/AAPT-Slides.pdf> (132 kB).

Hake, R.R. 2005a. “Will the No Child Left Behind Act Promote Direct Instruction of Science?” *Am. Phys. Soc.* **50**: 851 (2005); APS March Meeting, Los Angeles, CA. 21-25 March; online at <http://www.physics.indiana.edu/~hake/WillNCLBPromoteDSI-3.pdf> (256 kB).

Hake, R. R. 2005b. “The Physics Education Reform Effort: A Possible Model for Higher Education?” online at <http://www.physics.indiana.edu/~hake/NTLF42.pdf> (100 kB). This is a slightly edited version of an article that was (a) published in the *National Teaching and Learning Forum* 15(1), December, online to subscribers at <http://www.ntlf.com/FTPSite/issues/v15n1/physics.htm>, and (b) disseminated by the *Tomorrow's Professor* list <http://ctl.stanford.edu/Tomprof/postings.html> as Msg. 698 on 14 Feb 2006. For an executive summary see Hake (2006b).

Hake, R.R. 2005c. Review of Stephen Swidler's “Naturally Small: Teaching and Learning in the Last One-Teacher Schools,” 2 June, in *Education Review* <http://edrev.asu.edu/>; online at <http://www.physics.indiana.edu/~hake/RevSwidler25.pdf> (36 kB).

Hake, R.R. 2006a. “Measuring Teaching and Learning Performance: Interconnected Issues,” in *Proceedings of the Third International Conference on Measurement and Evaluation in Education (ICMEE 2006)*, Penang, Malaysia, 13-15 February; online at <http://www.physics.indiana.edu/~hake/ICMEEk-2006.pdf> (230 kB).

Hake, R.R. 2006b. “A Possible Model For Higher Education: The Physics Reform Effort (Author’s Executive Summary),” *Spark* (American Astronomical Society Newsletter), June, online at <http://www.aas.org/education/spark/SparkJune06.pdf> (1.9MB). Scroll down about 4/5 of the way to the end of the newsletter.

Hake, R.R. 2006c. "Possible Palliatives for the Paralyzing Pre/Post Paranoia that Plagues Some PEP's," *Journal of MultiDisciplinary Evaluation*, Number 6, November, online at <http://evaluation.wmich.edu/jmde/JMDE_Num006.html>. This even despite the admirable anti-alliteration advice at psychologist Donald Zimmerman's site <<http://mypage.direct.ca/z/zimmerma/>> to "Always assiduously and attentively avoid awful, awkward, atrocious, appalling, artificial, affected alliteration."

Hake, R.R. 2007a. "Should We Measure Change? Yes!" online as ref. 43 at <<http://www.physics.indiana.edu/~hake>>. To appear as a chapter in Hake (2007b). A severely truncated version appears in Hake (2006c).

Hake, R.R. 2007b. *Evaluation of Teaching and Student Learning in Higher Education*, Monograph, American Evaluation Association <<http://www.eval.org/>>, in preparation.

Hake, R.R. 2007c. "Design-Based Research in Physics Education Research: A Review," in A.E. Kelly, R.A. Lesh, & J.Y. Baek (in press), *Handbook of Design Research Methods in Mathematics, Science, and Technology Education*. Lawrence Erlbaum. Online at <<http://www.physics.indiana.edu/~hake/DBR-Physics3.pdf>> (xxkB). See also Hake (2004a, 2004c).

Hake, R.R. 2007d. "Can Scientific Research Enhance the Art of Teaching?" Greensboro AAPT meeting, invited paper DH02; abstract online at <<http://www.aapt.org/scheduler/SM2007/NameResult.cfm?Code=DH02>>, article soon to be online at <<http://www.physics.indiana.edu/~hake/EnhanceArt3.pdf>>.

Hake, R.R. 2007e. "Cognitive Science and Physics Education Research: 'What we've got here is a failure to communicate'," submitted to the Physics Education Research Conference (PERC 2007), August, 2007, Greensboro, NC; soon to be online at <<http://www.physics.indiana.edu/~hake/FailureCommunicate3.pdf>>.

Hake, R.R. 2007f. "The Socratic Method of Arons, Vlastos, Plato, and the Law Schools," *International Journal for the Scholarship of Teaching and Learning* <<http://www.georgiasouthern.edu/ijstol/>>, in preparation; to be online at <<http://www.physics.indiana.edu/~hake/SocraticArons3.pdf>>.

Hake, R.R. 2007g. "Fourteen Lessons from the Physics Education Reform Effort," *Latin American Journal of Physics Education*, in preparation; to be online at <<http://www.physics.indiana.edu/~hake/14Lessons3.pdf>>.