

## Education Articles, Materials, & Posts (1979 – 2003) \*‡§◇

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### I. ARTICLES AND MATERIALS

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 as ref. 4 at <<http://www.physics.indiana.edu/~hake>>.

Hake, R.R. 1987. "Promoting student crossover to the Newtonian world." *Am J. Phys.* **55**(10): 878-884.

Tobias S. & R.R. Hake. 1988. "Professors as physics students: What can they teach us?" *Am. J. Phys.* **56**: 786.

Hake, R.R. 1989. "What Went Unsaid at Physics Chairs Meeting," Letter to the Editor, *Physics Today* **43**(2): 158-159.

Hake, R.R. 1990. "Ph.D. Supply and Demand: Discordant Observations," Letter to the Editor, *Science* **249**(4969): 611, 10 August.

Hake, R.R. 1991. "Socratic Pedagogy in Introductory Physics," Letter to the Editor, *Physics Today* **44**(9).

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‡ The reference is: Hake, R.R. 2003. "Education Articles, Materials, & Posts " (1979 – 2003); online as reference 30 at <<http://www.physics.indiana.edu/~hake>>.

§ For a brief bio and listing of research articles on condensed-matter physics (1956-1989) click on [[VITA-052200.pdf, 48K](#)] on page 1 of <<http://www.physics.indiana.edu/~hake>>.

◇ Downloading of articles at <<http://www.physics.indiana.edu/~hake>> requires the free Adobe Acrobat "Reader," bundled on most modern browsers; also downloadable at <<http://www.adobe.com/products/acrobat/readstep2.html>> . .

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Hake, R.R. 1991. "My Conversion To The Arons-Advocated Method Of Science Education," *Teaching Education* **3**(2): 109-111; online as ref. 8 at < <http://www.physics.indiana.edu/~hake> >.

Hake, R.R. 1992. "Socratic pedagogy in the introductory physics lab." *Phys. Teach.* **30**: 546-552; updated version (4/27/98) online as ref. 23 at < <http://www.physics.indiana.edu/~hake> >.

Hake R.R. 1993. "Introducing Work," letter to the editor, *Phys. Teach.* **31**: 197.

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

Hake, R.R. 1994. "Some P201 Course Materials: Objectives, Background Questionnaire, Grading Acronym Guide"; online as ref. 1 at < <http://www.physics.indiana.edu/~hake> >.

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, and Swedish.

Hake, R.R. 1997. *Mechanics Test Data Survey Form*; online as ref. 5 at < <http://www.physics.indiana.edu/~hake> >.

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 SDI Lab #6 "Newton's Second Law Revisited ," online at < <http://www.physics.indiana.edu/~sdi> >.]

Hake, R.R. 1998. "Introduction to SDI Lab Teachers Guides"; online as ref. 7 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**: 64-74; online as ref. 24 at < <http://www.physics.indiana.edu/~hake> >.

Hake, R.R. 1998b. "Interactive-engagement methods in introductory mechanics courses," online as ref. 25 at < <http://www.physics.indiana.edu/~hake> >. Submitted on 6/19/98 to the *Physics Education Research Supplement to AJP (PERS)*." In this *sadly unpublished* (Physics Education Research has *no* archival journal!) crucial companion paper to Hake (1998a): average pre/post test scores, standard deviations, instructional methods, materials used, institutions, and instructors for each of the survey courses of Hake (1998a) are tabulated and referenced. In addition the paper includes: (a) case histories for the seven IE courses of Hake (1998a) whose effectiveness as gauged by pre-to-post test gains was close to those of T courses, (b) advice for implementing IE methods, and (c) suggestions for further research.

Hake, R.R. 1998. "Interactive-engagement vs Traditional Methods in Mechanics Instruction," *APS Forum on Education Newsletter*, Summer, p. 5-7, also as ref. 26 at < <http://www.physics.indiana.edu/~hake> >. Some criticisms of Hake (1998a) and of physics-education reform generally are countered.

Hake, R.R. 1999. "REsearch, Development, and Change in Undergraduate Biology Education (REDCUBE): A Web Guide for Non-Biologists" online at < <http://www.physics.indiana.edu/~redcube> >. This Adobe Acrobat portable document file (pdf) 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. The 9/8/99 version 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 Teacher's 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. 2000. "What Can We Learn from the Biologists About Research, Development, and Change in Undergraduate Education?" *AAPT Announcer* 29(4), 99 (1999); online as ref. 7 at < <http://www.physics.indiana.edu/~hake> >. The potential of the web as a mechanism for promoting interdisciplinary synergy in education reform is emphasized. See especially the figure on page 3.

Hake, R.R. 2000. "Towards Paradigm Peace in Physics Education Research," presented at the annual meeting of the American Educational Research Association, New Orleans, 24-28 April ; online as ref. 3 at < <http://www.physics.indiana.edu/~hake/> > . Also at that location is a pdf version "ParadigmSlides.pdf" of the PowerPoint slides shown at the meeting.

Hake, R.R. 2000. "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 2-2; abstract available at < <http://www.sci.cuny.cuny.edu/~rstein/perc2000.htm> > .

Hake, R.R. 2000. "The General Population's Ignorance of Science Related Societal Issues: A Challenge for the University," *AAPT Announcer* **30**(2): 105; online as ref. 11 at < <http://www.physics.indiana.edu/~hake/> > . Based on the earlier "The Science Illiteracy Crisis: A Challenge for The University," a libretto for a Wagnerian musical drama to be presented under the stars in the open-air Santa Fe Opera Theater, < <http://www.santafeopera.org/> >: an annotated interweaving of classic themes and original work, unpublished, 1989. 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 extraterrestrial intelligence.

Hake, R.R. 2000. "What Can We Learn from the Biologists About Research, Development, and Change in Undergraduate Education?" *AAPT Announcer* **29**(4), 99 (1999); available on the web as ref. 7 at < <http://www.physics.indiana.edu/~hake/> > . The potential of the web as a mechanism for promoting interdisciplinary synergy in education reform is emphasized and schematically pictured on page 3.

Hake, R.R. 2000. "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/> > as a pdf document, and as HTML plus video at < <http://hitchcock.dlt.asu.edu/media2/cresmet/hake/> > .

Hake, R.R. 2000. "Using the Web to Promote Interdisciplinary Synergy in Undergraduate Education Reform," *AAPT Announcer* **30**(4), 120. An updated version is soon to be on the web at < <http://www.physics.indiana.edu/~hake/> > .

Hake, R.R. 2000. "Is it Finally Time to Implement Curriculum S?" *AAPT Announcer* **30**(4), 103; online as ref. 13 at < <http://www.physics.indiana.edu/~hake> > (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 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 land-mark mathematics education research of Benezet (1935/36) [See the Benezet Centre < <http://www.inference.phy.cam.ac.uk/sanjoy/benezet/> >.]

Hake, R.R. 2001. "Suggestions for Administering and Reporting Pre/Post Diagnostic Tests"; online as ref. 14 at < <http://www.physics.indiana.edu/~hake> >.

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

Hake, R.R. 2002. "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 as ref. 17 at < <http://www.physics.indiana.edu/~hake> >.

Hake, R.R. 2002. "Assessment of Student Learning in Introductory Science Courses," *2002 PKAL Roundtable on the Future: Assessment in the Service of Student Learning*, Duke University, March 1-3; updated version of 1 June 2002 is online at < [http://www.pkal.org/template2.cfm?c\\_id=354](http://www.pkal.org/template2.cfm?c_id=354) > and as ref. 15 at < <http://www.physics.indiana.edu/~hake/> >. General information on the Roundtable and a hot-linked listing of all the papers is at < [http://www.pkal.org/template1.cfm?c\\_id=345](http://www.pkal.org/template1.cfm?c_id=345) >.

Hake, R.R. 2002. "Whence Do We Get the Teachers (Response to Madison)". *2002 PKAL Roundtable on the Future: Assessment in the Service of Student Learning*, Duke University, March 1-3; updated on 6/17/02; an initial fragment is online at < [http://www.pkal.org/template2.cfm?c\\_id=361](http://www.pkal.org/template2.cfm?c_id=361) >, for the complete paper see ref. 16 at < <http://www.physics.indiana.edu/~hake/> >.

Hake, R.R. 2002. "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 as ref. 22 at < <http://www.physics.indiana.edu/~hake> >.

Hake, R.R. 2002. "Issues Related to Quantitative Methods and Data Analysis in PER: Part I – A Primer for Pre/Post Testers," Invited Breakout Session Presentation, Physics Education Research Conference; Boise, Idaho; August 2002. This has been superseded by the *UNESCO-ASPEN* paper "Assessment of Physics Teaching Methods," (see below).

Hake, R.R. 2002. "Assessment of Physics Teaching Methods, *Proceedings of the UNESCO-ASPEN Workshop on Active Learning in Physics*, Univ. of Peradeniya, Sri Lanka, 2-4 Dec. 2002; also online as ref. 29 at < <http://www.physics.indiana.edu/~hake/> >.

Hake, R.R. 2002. "Re: Problems with Student Evaluations: Is Assessment the Remedy?" online as ref. 18 at < <http://www.physics.indiana.edu/~hake> > and as HTML at < <http://www.stu.ca/~hunt/hake.htm> >.

Hake, R.R. 2002. "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; also online as ref. 28 at < <http://www.physics.indiana.edu/~hake/> >.

Hake, R.R. 2002. "Re: Socratic Method," PhysLrnR/Phys-L/Physhare/AP-Physics post of 14 Nov 2002 14:32:54-0800; online at < <http://lists.nau.edu/cgi-bin/wa?A2=ind0211&L=phys-l&F=&S=&P=15118> >.

Mallow, J.V. & R.R. Hake. 2002. "Gender Issues in Physics/Science Education (GIPSE) – Some Annotated References"; online at < <http://www.luc.edu/depts/physics/fac/mallow.html> >, as ref. 21 at < <http://www.physics.indiana.edu/~hake> >, and at the APS website < <http://www.aps.org/educ/cswp/women-links.html> >. Contains about 300 references and 200 hot-linked URL's.

Hake, R.R. 2002. "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. 2002. "Physics First: Opening Battle in the War on Science/Math Illiteracy?" Submitted to the *American Journal of Physics* on 27 June 2002; online as ref. 29 at < <http://www.physics.indiana.edu/~hake/> >.

Hake, R.R. 2003. "Socratic Dialogue Inducing (SDI) Labs Web Site < <http://www.physics.indiana.edu/~sdi> >. Contains a brief description of SDI Labs with pertinent references and 9 SDI Lab Manuals that may be freely downloaded.

Hake, R.R. 2003. "SDI Labs," at the Harvard Galileo site < <http://galileo.harvard.edu/> >. The Galileo site is a leading resource for online teaching materials. Under "Teaching Materials" click on "Socratic Dialogue Inducing Labs" to bring up sections on: "What is SDI?", "Who Can Use SDI?", "More About SDI", "What Are the Requirements?", "Benefits," and "Resources for SDI." In addition, Teacher's Guides for SDI Labs #0.2 "Introduction to Kinematics" and #3 "Circular Motion and Frictional Forces" are at < <http://galileo.harvard.edu/> > / "Socratic Dialogue Inducing Labs" / "Resources for SDI" / "Teacher's Guides", where "/" means "click on." I hope to add Teacher's Guides for SDI Labs #1 and #2 on or before December 2003.

## II. ACCESS TO DISCUSSION LIST POSTS

The archives of discussion lists to which I occasionally contribute are shown below. Those with LISTSERV archives by L-Soft < <http://www.lsoft.com/> > are preceded by an asterik \*. To access those posts:

- a. click on the archive URL ;
- b. click on "Search the archives" to bring up the powerful LISTSERV search engine;
- c. type "Hake" (without the quotes) into the "Author" slot to obtain the number of hits (as of 8/17/03) indicated in right-hand column, and a hot-linked listing of the titles of posts.

To access my posts on a particular topic, as e.g., "Socratic", add to "c": type "Socratic" (without the quotes) into the "Search for" slot. For example at Phys-L, that search yields 40 hits (as of 8/17/03).

In the interest of inter- and intra-disciplinary synergy,\*† I often cross-post (i.e., send the same message to two or more lists). Therefore the total number of hits 1642 shown in the last row exceeds the number of messages that I have composed, probably by a factor of about 2.

*AERA-C (Learning & Instruction)	
< <a href="http://lists.asu.edu/archives/aera-c.html">http://lists.asu.edu/archives/aera-c.html</a> > .....	3
*AERA-D (Measurement and Research Methodology)	
< <a href="http://lists.asu.edu/archives/aera-d.html">http://lists.asu.edu/archives/aera-d.html</a> > .....	101
*AERA-Teaching-EdPsych (Teaching Psychology Special Interest Group)	
< <a href="http://listserv.temple.edu/archives/teaching_edpsych.html">http://listserv.temple.edu/archives/teaching_edpsych.html</a> > .....	8
AP-Physics (Advanced Placement Physics)	
< <a href="http://lyris.collegeboard.com/cgi-bin/lyris.pl?site=collegeboard&amp;enter=ap-physics">http://lyris.collegeboard.com/cgi-bin/lyris.pl?site=collegeboard&amp;enter=ap-physics</a> > .	55

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\* Hake, R.R. 2000. "What Can We Learn from the Biologists About Research, Development, and Change in Undergraduate Education?" *AAPT Announcer* **29**(4), 99 (1999); available on the web as ref. 7 at < <http://www.physics.indiana.edu/~hake> >. The potential of the web as a mechanism for promoting interdisciplinary synergy in education reform is emphasized and schematically pictured on page 3.

† MacIsaac, D.L. 2000. "Communities of on-line physics educators," *Phys. Teach.* **38**(4): 210-213; online at < <http://PhysicsEd.BuffaloState.edu/PHYS-L/index.html> >. Gives reference information on four major physics education lists: PHYS-L, PHYSHARE-L, PhysLrnR, and TAP-L.

*ASSESS (Assessment in Higher Education)	
< <a href="http://lsv.uky.edu/archives/assess.html">http://lsv.uky.edu/archives/assess.html</a> > .....	58
Astro-Ed (Association of Astronomy Educators)	
< <a href="http://groups.yahoo.com/group/astroed_news">http://groups.yahoo.com/group/astroed_news</a> > .....	0
*Biopi-L (Biology Teachers and Professionals from Kindergarten to the University)	
< <a href="http://listserv.ksu.edu/archives/biopi-l.html">http://listserv.ksu.edu/archives/biopi-l.html</a> > .....	58
*Chemed-L (Chemistry Education)	
< <a href="http://mailer.uwf.edu/archives/chemed-l.html">http://mailer.uwf.edu/archives/chemed-l.html</a> > .....	68
*Dewey-L (John Dewey)	
< <a href="http://listserv.sc.edu/archives/dewey-l.html">http://listserv.sc.edu/archives/dewey-l.html</a> > .....	11
*DrEd (Medical Education Research and Development)	
< <a href="http://list.msu.edu/archives/dr-ed.html">http://list.msu.edu/archives/dr-ed.html</a> > .....	7
EdStat (Statistics)	
< <a href="http://jse.stat.ncsu.edu/archives/">http://jse.stat.ncsu.edu/archives/</a> > .....	2
*§EVALTALK (American Evaluation Association Discussion List)	
< <a href="http://bama.ua.edu/archives/evaltalk.html">http://bama.ua.edu/archives/evaltalk.html</a> > .....	86
*FYA (First Year Assessment)	
< <a href="http://listserv.sc.edu/archives/fya-list.html">http://listserv.sc.edu/archives/fya-list.html</a> > .....	11
Math-Learn (Math Education – primarily K-12)	
< <a href="http://groups.yahoo.com/group/math-learn/">http://groups.yahoo.com/group/math-learn/</a> > .....	13
Math-Teach (Math Education)	
< <a href="http://mathforum.org/epigone/math-teach">http://mathforum.org/epigone/math-teach</a> > .....	63
OpenPhys (Open-Source Physics Education Materials)	
< <a href="http://www.topica.com/lists/openphys/read">http://www.topica.com/lists/openphys/read</a> > .....	5
*Phys-L (Forum for Physics Educators)	
< <a href="http://lists.nau.edu/archives/phys-l.html">http://lists.nau.edu/archives/phys-l.html</a> > .....	221
*§PhysLrnR (Physics Learning Research List)	
< <a href="http://listserv.boisestate.edu/archives/physlrnr.html">http://listserv.boisestate.edu/archives/physlrnr.html</a> > .....	409

*Physhare (Sharing Resources for High School Physics) < <a href="http://lists.psu.edu/archives/physhare.html">http://lists.psu.edu/archives/physhare.html</a> > .....	112
*PHYSOC (Physics and Society) < <a href="http://listserv.uark.edu/archives/physoc.html">http://listserv.uark.edu/archives/physoc.html</a> > .....	11
*PPAS (Promising Practices in After School Programs) < <a href="http://listserv.aed.org/archives/ppas.html">http://listserv.aed.org/archives/ppas.html</a> > .....	5
*POD (Professional and Organizational Development) < <a href="http://listserv.nd.edu/archives/pod.html">http://listserv.nd.edu/archives/pod.html</a> > .....	209
*STLHE-L (Student Teaching and Learning in Higher Education) < <a href="http://listserv.unb.ca/archives/stlhe-l.html">http://listserv.unb.ca/archives/stlhe-l.html</a> > .....	<u>126</u>
TAP-L (Technical Aspects of Physics Labs & Lectures) < <a href="http://listproc.appstate.edu:8000/guest/archives/TAP-L/">http://listproc.appstate.edu:8000/guest/archives/TAP-L/</a> > .....	<u>0</u>
<b>TOTAL HITS .....</b>	<b>1642</b>

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§PhysLrnR and EvalTalk are unusual among LISTSERV discussion list in that one must subscribe to those lists in order to access their archives. But it takes only a few minutes to subscribe and then unsubscribe by following the simple directions at the <ArchiveURL> / "Join or leave the list (or change settings)" where "/" means "click on." Rather than unsubscribe after using the archives, it's easier to subscribe in the first place using the "NOMAIL" option under "Miscellaneous." Then, as a subscriber, you may access the archives and/or post messages at any time, while receiving NO MAIL from the list!

The trick to monitoring posts on the archives is to:

- a. click on the week(s) or months of interest,
- b. arrange the posts *chronologically* by clicking on "Date" in the "Sort by" menu at the top of the page, or else clicking on the second icon from the left with sheets # 1, 2.
- c. scan the titles and authors of posts that have arrived since your last visit, and examine only those which appear worthwhile.