

Comment on “How do we know if we’re doing a good job in physics teaching?” by Robert Ehrlich [Am. J. Phys. 70 (1), 24-29 (2002)] *

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In his recent perspective on the above question, Robert Ehrlich set forth some good ideas, but, in my opinion, faltered in his criticism of my survey article.¹ Ehrlich opens his criticism with the misleading statement: “Taken at face value ... (Hake’s results¹) ... would seem to imply that *traditional instruction, that is lecturing*, is of very little value, while instruction that interactively engages students yields much greater gains ... I am unwilling to take ... (Hake’s) ... claims at face value for at least four reasons.” (My italics.)

In the above quote, Ehrlich set up a straw man so that he could then demolish him (but *not* my research) with these correct statements: “... good lectures may, through a judicious use of peer instruction a la Mazur, engage their students to a greater degree than teachers who do no lecturing. In fact, according to Joe Redish, some of the largest FCI (Force Concept Inventory) gains he has ever observed were in a large (though highly interactive) lecture class. In short, contrary to the rhetoric of some, we should not equate instruction via lecture mode to passive student experiences.”

From a *careful* reading of my article,¹ one discovers that I did *not* equate traditional instruction with lecturing, and I was well aware of Mazur’s work, and, in fact, included his gain results in my “interactive engagement” (IE) data. I *operationally* defined “traditional” (T) courses as “those reported by instructors to make little or no use of IE methods, relying primarily on *passive-student* lectures, recipe labs, and algorithmic-problem exams.” Here IE methods were *operationally* defined as “those designed at least in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hand-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors, all as judged by their literature descriptions.” Thus Ehrlich’s third, and “most important of all” reason for not accepting my claims at face value, “The IE versus non-IE classification is a blurry one,” does *not* apply to the operational definitions that formed the basis of my research, nor does it undermine my conclusion¹ that *the conceptual and problem-solving test results strongly suggest that the classroom use of IE methods can increase mechanics-course effectiveness well beyond that obtained in traditional practice.*

*The reference is R.R. Hake, "Comment on 'How do we know if we’re doing a good job in physics teaching?' by Robert Ehrlich [Am. J. Phys. 70(1), 24-29 (2002)]," Am. J. Phys. 70(9) (2002) and < <http://www.physics.indiana.edu/~hake> >.

Here are Ehrlich's remaining reasons 1, 2, and 4 for not accepting my claims at face value, followed by brief rebuttals:

1. "I am not convinced that the claim of greater conceptual understanding gains on the FCI test in IE classes may not be due in part to some amount of 'teaching to the test.' "

As far as I know, the previously given^{1,2} counters to such criticism have been accepted by most critics who have taken the time to read the arguments. To save space, I shall not repeat them here except to reiterate that, in the broadest sense, IE courses all "teach to the test" to some extent, if this means teaching so as to give students some understanding of the basic concepts of Newtonian mechanics as examined on the FCI.

2. ". . . the IE versus non-IE comparison is hardly a double blind one, because both Hake and the course instructor knew both the category the course is being placed into (IE or non-IE), as well as the FCI gain for that class."

In the case of a survey such as mine, it is not clear that blindness to differences in T and IE physics instruction could have been found in any potential surveyors, physics teachers, or students who were not medically institutionalized. Non-double-blind education research experiments may be less convincing than some double-blind medical experiments, but that doesn't mean that the education results should necessarily be taken at *less* than face value. In the case of my survey, I think that the results merit acceptance at *full* face value, especially considering the fact that normalized gain differences between T and IE courses that are consistent with those I reported, have now been obtained by physics education research groups³ at the University of Maryland [Redish *et al.* (1997), Saul (1998), Redish and Steinberg (1999), Redish (1999)], the University of Montana [Francis *et al.* (1998)], Rennselaer and Tufts Universities [Cummings *et al.* (1999)], North Carolina State University [Beichner *et al.* (1999)], Hogskolan Dalarna - Sweden [Bernhard (2001)], Carnegie Mellon University [Johnson (2001)], and City College of New York [Steinberg and Donnelly (2002)].

4. "I would be more willing to accept that IE classes show greater conceptual gains if those gains were shown to be of value in follow-on courses, specifically if they led not only to greater student entre in the major, but more importantly to higher numbers of physics graduates."

This is a legitimate reason for doubt, but already some longitudinal studies have shown encouraging results that may reduce Ehrlich's skepticism: for example, evidence (see Ref. 3 for references) that learning in IE physics courses is substantially retained 1 to 3 years after the

courses have ended [Chabay (1997), Francis *et al.* (1998), Bernhard (2001)]. But increasing the numbers of physics graduates will require, in my view, in addition to increased effectiveness of introductory courses, a move towards “science/math literacy for all” in K-12 education,⁴ and the implementation of the 1960’s Curriculum S for “Synthesis.”⁵

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¹ R. R. Hake, “Interactive-engagement versus traditional methods: A six thousand student survey of mechanics test data for introductory physics courses,” *Am. J. Phys.* **66**(1), 64–74 (1998) and < <http://www.physics.indiana.edu/~sdi/> >.

² R. R. Hake, “Interactive-engagement versus traditional methods in mechanics instruction,” *APS Forum on Education Newsletter*, Summer 1998, pp. 5-7 and < <http://www.physics.indiana.edu/~sdi/> >.

³ R. R. Hake, “Lessons from the physics education reform effort,” *Conservation Ecology* **5** (2), 28 (2002); < <http://www.consecol.org/vol5/iss2/art28> >.

⁴ R. R. Hake, “*Physics First*: Precursor to science/math literacy for all?,” *APS Forum on Education Newsletter*,” Summer 2002 (in press); online at < <http://www.aps.org/units/fed/index.html> > / "Forum newsletters" where "/" means "click on."

⁵ R. R. Hake, “Is it finally time to implement Curriculum S?,” *AAPT Announcer* **30**(4), 103 (2000); online at < <http://www.physics.indiana.edu/~hake> >.