engaged in translating McDermott's modules into Polish and designing and attempting to implement a program of instruction by inquiry in Warsaw.

The most recently published longitudinal study that I could find about Discovery[1] describes its pioneering role in Ohio. The study concludes that "Further explorations of the data . . . would help to provide further evidence about the link between inquiry-based instructional practice and student achievement and help to tease out the effects of different intensities of training." This is far from saying that a successful systemic reform has been accomplished.

As part of that study, nearly 1500 trained teachers were surveyed by mail over a four-year period before 1997; they were asked about their attitudes toward using the inquiry-based classroom methods they had been taught. Although the study suggests that students of teachers trained in Discovery fared better than students of a control group, it also says that over time the number of mail survey responses from the trained teachers dropped by half. The study did not find why, and the margin of error in interpreting various numbers found in the study is unknown. Carl Wieman has stressed the need for extreme caution in measuring results of teaching and warns university faculties that they can easily create for themselves illusions about what students actually learn.[2] I have not found any research results on Discovery more recent than 2000.

The reviewer complains that *Productive Learning* does not refer to the 1999 National Research Council report *How People Learn: Brain, Mind, Experience, and School*. Instead we chose to underscore two studies of successful school programs by David Bensman[3] and Eliot Levine[4] that are probably more useful to the intended audience.

Although the review decries parts of the book on psychology of learning and reform, it speaks highly about the part on Einstein's energy–mass formula. That reflects a general problem of physicists and physics educators: They have not yet come to terms with the context of the interpersonal relationship between teacher and student and its role in science education. The lack of understanding of that context goes a long way toward explaining why science education reform has not been successful: One teaches students, not the subject matter.

Lastly, the review avoids entirely the book's central message concerning the relevance of science, art, and Einstein's relativity to educational reform. Therefore, this review is a disservice to the field; it steers educators away from a positive resource.

References

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Grayson replies: I shall address Stanisław Głazek's points one by one. The authorship of each chapter is not explicitly stated, but I include teacher learning as part of "educational matters at pre-college levels." Although the authors mention works by three highly regarded physics educators, results of the vast body of physics education research do not seem to have played a role in framing their arguments or moderating their criticisms. Yet physics education research has provided a wealth of useful insights for addressing issues the authors refer to, including the different frames of reference of students and teachers and aspects of physics learning environments that lead to productive learning. Reinders Duit compiled the most comprehensive list of such references.[1] ComPADRE (http://www.compadre.org), a collaboration of several physics and astronomy professional associations, maintains a website of physics teaching and education research resources.

NSF has supported a number of systemic reform initiatives over the past two decades, of which Discovery was one. As an example of the outcomes, NSF reports,

> During the 1994–95 school year, the first year that NSF funded the urban systemic program, Chicago's school system saw significantly more of its students score above the national norm in mathematics on a commonly used assessment called the Iowa Tests of Basic Skills. What's more, Chicago students' performance in mathematics has increased in 61 out of 62 high schools, suggesting that improvement is occurring across the board.[2]

My reference to *How People Learn: Brain, Mind, Experience, and School* was not because it describes successful school programs (it does not), but because it comprises a synthesis and overview of research into the process of learning, which the authors conclude "has gone unexamined."

Głazek states that I decried "parts of the book on psychology of learning and reform." That is not true. Nor would I deny the central role of the relationship between student and teacher in student learning. My criticisms were of the writing style—I found the sections on the psychology of learning and educational reform to be overly wordy and poorly integrated into the sections on Albert Einstein and his science. If the central point of the book is to come across more clearly, the services of a good editor are needed.

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Fleshing out the search for WIMPs

Bertram Schwarzschild's story "A Bubble Chamber Brings New Capabilities to the Search for WIMPs" (PHYSICS TODAY, April 2008, page 22) is undoubtedly interesting, and the application of bubble chamber technology to searches for weakly interacting massive particles (WIMPs) by the COUPP collaboration is certainly newsworthy. However, the only "new capability" brought to bear is the spatial concentration of the active detector mass: For several years the SIMPLE[1] and PICASSO[2] research teams have used superheated liquid microdrops suspended in a gel matrix, in concentrations of 1% to 3%. The background insensitivity capabilities of these superheated suspensions are the same as a bubble chamber's, since the underlying physics is the same. The continuous-sensitivity difficulty is why the droplet suspensions were developed in the first place; the devices are continuously sensitive for up to 100 days in the case of SIMPLE, and longer with repressurization as in PICASSO.

Achieving large active mass has simply required space and engineering of the instrumentation. The COUPP team,