Is it time for a science counterpart of the Benezet–Berman mathematics teaching experiment of the 1930’s?

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Abstract. Should teachers concentrate on critical thinking, estimation, measurement, and graphing rather than college-clone algorithmic physics in grades K–12?3 Thus far physics education research offers little substantive guidance. Mathematics education research addressed the mathematics analogue of this question in the 1930’s. Students in Manchester, New Hampshire were not subjected to arithmetic algorithms until grade 6. In earlier grades they read, invented, and discussed stories and problems; estimated lengths, heights, and areas; and enjoyed finding and interpreting numbers relevant to their lives. In grade 6, with 4 months of formal training, they caught up to the regular students in algorithmic ability, and were far ahead in general numeracy and in the verbal, semantic, and problem solving skills they had practiced for the five years before. Assessment was both qualitative – e.g., asking 8th grade students to relate in their own words why it is ‘that if you have two fractions with the same numerator, the one with the smaller denominator is the larger’; and quantitative – e.g., administration of standardized arithmetic examinations to test and control groups in the 6th grade. Is it time for a science counterpart of the Benezet/Berman Manchester experiment of the 1930’s?

1 Rote learning: Opium for the mind

Traditionally taught science and mathematics teach little except obedience. Here are examples for the skeptical. This gem is discussed by Alan Schoenfeld (1987):

One of the problems on the NAEP [National Assessment of Educational Progress] secondary mathematics exam, which was administered to a stratified sample of 45,000 students nationwide, was the following: An army bus holds 36 soldiers. If 1128 soldiers are being bused to their training site, how many buses are needed?

Seventy percent of the students who took the exam set up the correct long division and performed it correctly. However, the following are the answers those students gave to the question of ‘how many buses are needed?’: 29% said...31 remainder 12; 18% said...31; 23% said...32, which is correct. (30% did not do the computation correctly).

It’s frightening enough that fewer than one-fourth of the students got the right answer. More frightening is that almost one out of three students said that the number of buses needed is ‘31 remainder 12’. [emphasis added]

Mathematics has no meaning for most students; it is a sequence of mysterious steps, which the clever or obedient quickly master to score high on examinations. More disturbing than mindless mathematics are examples showing that students are not bothered by nonsense. An example from Schoenfeld (1991) shows the trouble:

In his dissertation research, Kurt Reusser . . . (Reusser 1988) . . . asked 97 first and second grade students the following question: ‘There are 26 sheep and 10 goats on a ship. How old is the

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2. Partially supported by NSF Grant DUE/MDR-9253965
3. For non-US readers: Children begin kindergarten (grade K) roughly at age 5 and finish the highest grade (12) roughly at age 18.
Seventy-six of the 97 students ‘solved’ the problem, providing a numerical answer by adding 26 and 10.

School aggravates the problem. Into sets of problems worked by school children, Radatz (cited in Schoenfeld (1989)) inserted non-problems such as the following (in its entirety!):

Mr. Lorenz and 3 colleagues started at Bielefeld at 9 a.m. and drove the 360 km to Frankfurt, with a rest stop of 30 minutes.

The percentage of students who answer such non-problems increases consistently from kindergarten through 6th grade. The more time students spend in rote learning, the more brain-dead they become.

The problem is international. One of the authors (SM) gave this problem to a sample of physics majors at the University of Cambridge:

Two people are on opposite sides of a rotating merry-go-round. One throws a ball to the other. In which frame of reference is the path of the ball straight when viewed from above? Choices: (a) the earth, (b) the merry-go-round, (c) both, or (d) neither.

Only 58% of physics majors answered correctly; of whom only 40% were sure of their answer. The success rate did not increase with more years of studying physics. It seems that even very talented physics students depend on rote learning.4

2 Benezet’s (1935a, 1935b, 1936) curriculum

Etta Berman, a teacher who worked under Benezet as a K-12 teacher in Manchester, and researched the Benezet method for her master’s thesis (Berman 1935), reports an interview in which Benezet commented with characteristic pungency:

We have been chloroforming children’s reasoning powers. We have been drilling them in formulae and tables to the detriment of their reasoning ability. (Berman 1935, p. 45)

Berman summarized Benezet’s views as:

...greater intellectual powers can be secured by warding off material which makes for mental stunting and substituting in its place content in which the children find enjoyment, as well as things common to their understanding, experience, and environment.

...formal arithmetic drilled before the child’s reasoning powers are developed is one of the underlying causes for stunted reasoning powers. (Berman 1935, p. 46)

In two sentences Benezet described his method:

Teachers were told to soft-pedal the mechanical arithmetical drills and to concentrate on reasoning, estimation, and on self-expression. They were asked to give the children a great number of books to read, and to encourage oral English in telling the story of these books. (Berman 1935, p. 46)

Students learnt mathematics in context.5 First-graders meet small numbers:

This instruction is not concentrated into any particular period or time but comes in incidentally in connection with assignments of the reading lesson or with reference to certain pages of the text.

Second graders make friends with larger numbers (their readers are longer):

If any book used in this grade contains an index, the children are taught what it means and how to find the pages referred to. Children will naturally pick up counting in the course of games which they play.

4. More details of the questions and answers are on the web at ⟨http://www.inference.phy.cam.ac.uk/sanjoy⟩.

5. A warning to those thinking of trying the method or of criticizing it for avoiding all arithmetic: ‘Some teachers, new in the experiment, have steered clear of all arithmetic but Mr. Benezet’s idea is really to teach any arithmetic as the need comes up but not on the plane of formal drill.’ (Berman 1935, p. 48)
Table 1. Benezet's curriculum.

| Grade | Mathematics ideas |
|-------|-------------------|
| 1     | Numbers < 100; comparison: more, less, higher, lower |
| 2     | Telling time (hours and half-hours) page numbers; using an index. |
| 3     | Bigger numbers: license plates, house numbers. |
| 4     | Inch, foot, yard. Estimating lengths. Square inch, square foot. |
| 5B    | Counting by 5’s, 10’s, 2’s, 4’s, and 3’s (mentally), leading to those multiplication tables. Estimation games; always writing estimate before checking. Fractions by pictures. |
| 5A    | Multiplication table. |
| 6     | Formal arithmetic, but estimate first then check. |
| 7     | Lots of mental arithmetic without reference to paper or blackboard. |
| 8B    | More mental arithmetic. |
| 8A    | Reasons for processes. Explaining how to attack problems. |

The principle of learning in context continues through the entire curriculum. A short summary of each year’s curriculum is in Table 1; detailed descriptions are in (Benezet 1935b).

3 Assessment

Benezet combined qualitative and quantitative assessment, the better to convince people who accept one or other kind of evidence.

As a qualitative assessment, he asked students questions that appear ridiculously easy:

The distance from Boston to Portland [Maine] by water is 120 miles. Three steamers leave Boston, simultaneously, for Portland. One makes the trip in 10 hours, one in 12, and one in 15. How long will it be before all 3 reach Portland? (Benezet 1936)

In the regularly taught 9th grade, 6 out of the 29 students (!) got it right. In the experimental 2nd grade, all students got it right. Benezet does not say what answer the regularly taught 9th-grade students gave, but the example of sheep and goats suggests that it was probably 37.

Benezet also asked students to explain their thinking:

I was trying to get the children to tell me, in their own words, that if you have two fractions with the same numerator, the one with the smaller denominator is the larger.

From the regularly taught 8th grade, he got: ‘The smaller number in fractions is always the larger’, and ‘The denominator that is smallest is the largest.’

Etta Berman, in her Masters thesis (1935) on the Benezet experiment, used numerous quantitative assessments:

- verbal: antonyms, synonyms, alphabet, analogies, anagrams
- mathematical: word problems, single- and multidigit addition and multiplication; subtraction, addition, multiplication, and division of fractions; long division
- everyday knowledge: ‘common sense’; typical prices (e.g. of gasoline and coal), interest rates, and discounts
In formal arithmetic, the experimental students caught up to the regular ones in only 4 months during the 6th grade. As Berman concluded with academic understatement: ‘The results of this study cast doubt upon whether we are justified in devoting five years to the drilling of formal arithmetic’ (Berman 1935, p. 40). The experimental students instead got years of extra practice in reading, writing, and thinking:

In one [traditionally taught] fourth grade I could not find a single child who would admit that he had committed the sin of reading. I did not have a single volunteer, and when I tried to draft them, the children stood up, shook their heads, and sat down again. In the four experimental fourth grades the children fairly fought for a chance to tell me what they had been reading. The hour closed, in each case, with a dozen hands waving in the air and little faces crestfallen, because we had not gotten around to hear what they had to tell. (Benezet 1935a)

4 Teaching for transfer

The examples of the army buses and of the steamers going to Portland show that traditionally taught students cannot use their knowledge except in rote, classroom problems. In traditional mathematics teaching, the applications are similar to one another, so the ideas common to all the applications include much besides the essentials. Thus the student cannot easily abstract the essential, transferable ideas (Figure 1). For an idea to transfer, students must apply it in widely differing contexts. Bransford, Brown, and Cocking (1999, ch. 3) give a valuable discussion of transfer; see especially the references on how ‘contrasting cases’ enhance transfer (p. 48). By having students read stories, poems, and adventures, by having them read geography and history, and by having them invent their own stories, Benezet introduced students to a vast diversity of mathematical applications. In this rich environment, students learnt mathematical skills useful well beyond the classroom.

Figure 1. Why ‘knowledge’ from traditional mathematics teaching does not transfer. (a) Ideas used in an application, showing contingent, contextual ideas (C) and essential ideas (T), the ones of general use that you would like students to transfer automatically to other contexts. (b) Traditional course with two applications. The contexts are similar, so the intersection of the two applications (shaded area) includes much more than the essentials of the transferable ideas (darker shaded area). (c) Teaching for transfer. Here the contexts are diverse, so the intersection is mostly the essentials of the ideas.

5 Mathematical proficiency

In a recent National Research Council report, Adding It Up: Helping Children Learn Mathematics, Kilpatrick et al. (2001) advise revamping P–8 (ages 3–12) mathematics education so that all
students attain ‘mathematical proficiency’:

- **conceptual understanding**: comprehension of mathematical concepts, operations, and relations
- **procedural fluency**: skill in carrying out procedures flexibly, accurately, efficiently, and appropriately
- **strategic competence**: ability to formulate, represent, and solve mathematical problems
- **adaptive reasoning**: capacity for logical thought, reflection, explanation, and justification
- **productive disposition**: habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy

According to committee chair Jeremy Kilpatrick (as quoted by Mervis 2001): ‘We want to move past the . . . [‘Math Wars’] . . . debate over skills versus understanding. It’s not one or the other. The point is that both are needed, and more, to learn and understand mathematics.’

Berman’s (1935) study suggests that Benezet’s 8th-grade students possessed far greater mathematical proficiency in the above sense than did regularly taught students. Perhaps the Math Wars can end in a Treaty of Benezet, in the spirit of *Adding It Up*, and acceptable to both sides, e.g., to the ‘Mathematically Correct’ (http://mathematicallycorrect.com) and the ‘Mathematically Sane’ (http://mathematicallysane.com).

The requirements for mathematical proficiency given by Kilpatrick et al. (2001) are consistent with Benezet’s curriculum (Table 1); they complement the Benezet/Swartz physics topics (Tables 2 and 3); and they mesh with the features of science literacy listed by Arons (1990).

### 6 Physics

A physics counterpart of the Benezet experiment could include a huge variety of ideas. In Table 2 we sketch a possible curriculum.

**Table 2. A possible physics curriculum.**

| Grade | Physics and mathematics ideas |
|-------|------------------------------|
| 1–8   | Benezet’s mathematics program as a basis. Add physical quantities to it: angles, volumes, weight (mass), force (estimating only), density as students learn division, energy, power. All quantities are related to everyday experience: density of rocks, volume of houses, power required in climbing stairs or cycling, power in the falling water at Niagara Falls. Proportional reasoning and scaling: ‘If you double the side of a cube, what happens to the volume?’ Use scaling throughout, starting in grade 4, with the introduction of square measure, and emphasize it especially in grade 8. |
| 9-11  | Gravitation, motion of planets by hand simulation to develop a tick-by-tick model of how Newton’s second law works. Dimensions, units, dimensional analysis to guess formulae. Springs, waves, sound, music, pressure. Matter is made of atoms. This order would fit with a physics-first curriculum (Livanis 2001) as suggested by Leon Lederman (1999). |
| 12    | Begin exact calculations, including conservation laws. |
Qualitative assessment could include estimation problems:

- How many miles must I run to burn off the calories from a candy bar?
- How high can animals jump as a function of size?
- Why are hummingbirds so tiny?
- Estimate for your country the fractional change in the average miles per gallon (or km/liter) of gasoline used by automobiles if the speed limit is changed from 55 mph (or 88 km/hr) to 75 mph (or 120 km/hr).

High-school students could try to find flaws in perpetual-motion machines. Here are two such machines:

1. Bouncing. A ball bounces elastically off a wall (in one dimension): It strikes and rebounds with velocity \( V \) and energy is conserved. In a reference frame that moves with the initial velocity of the ball, the ball before the bounce has velocity 0; and after the bounce, velocity \( 2V \). In this frame, energy is not conserved. Are you worried?

2. Buoyancy.

![Buoyancy Diagram](image)

The figure shows a cross-section of a long trough, showing a cylinder free to rotate about the spindle at its center, but not free to move off axis. The mercury and water are kept from mixing by an impermeable membrane. The upward arrows show the buoyant forces on each half of the cylinder, with the mercury’s contribution greater than the water’s by a factor of 13 (the density ratio). So the spindle should rotate and, by symmetry, keep rotating. Perpetual motion?

After completing Table 2, we stumbled across an editorial by Cliff Swartz (1993). Swartz suggests topics (Table 3) for K–12 science education that seem compatible with the physics and mathematics ideas of Table 2. His description of how to chose the important topics reminds us of Benezet:

Here are some samples of my proposed standards for physics topics... The theme is that... all physics standards K–12 should emphasize the quantitative... I mean dealing with the size of things, relating numbers to measurable and measured magnitudes, necessarily therefore paying attention to significant figures and knowing how to do order-of-magnitude, zeroing-in calculations... my elementary-school science standards involve only topics and experiences that are literally tangible. The change to abstraction should be proceed only during junior high, in general to be introduced only after concrete examples... The National Committee, NSTA, AAAS, Albert Shanker, and everyone else is making lists of standards. Physics teachers should produce their own list before some power from on high congeals a new federal dogma in our name.

What is the relationship of the Benezet/Swartz material in Tables 2 and 3 to the physical-science portion of the National Science Education Standards (National Research Council 1996a) shown in Table 4? The Benezetian items in Tables 2 and 3 are concrete examples of general categories in Table 4. In our view, Tables 1 and 2 may give teachers a clearer idea of possible nuts and bolts for a worthwhile K–12 science and mathematics education.
Table 3. Possible topics for K–12 suggested by Swartz (1993).

| Grade | Physics and mathematics topics |
|-------|--------------------------------|
| 1–6   | Use standard measuring tools.  |
|       | Students measure their foot lengths, then organize and interpret a class distribution graph. |
|       | Students time their pulses, plot a distribution of class results, and make comparisons with results of before and after physical exercise. |
|       | Select the needed apparatus and make all the measurements, calculations, and graphs to determine who runs faster in their class, tall kids or short kids. |
| 7–9   | Use standard measuring tools.  |
|       | Use wire, battery, and bulb with the right tools and connectors to make the bulb light. |
|       | With a convex lens as a magnifier, produce both real and virtual images. |
|       | Measure the volume and mass of an object and calculate its density. |
|       | Measure work input and output of a simple machine. |
|       | Use echoes to measure the speed of sound. |
| 10–12 | Use standard measuring tools.  |
|       | Given the mass of a pollutant in a quantity of water, calculate the degree of pollution in parts per million. |
|       | Organize the history of the universe on a power-of-ten map. |
|       | Characterize the electromagnetic spectrum in terms of wavelengths, frequencies, and photon energies, doing necessary calculations and examples to illustrate each regime. |
|       | Use Archimedes’ principle to explain how a boat floats. |

After considering Benezet’s articles, the late Arnold Arons (2000) wrote to us:

I have looked at the Benezet papers, and I find the story congenial. The importance of cultivating the use of English cannot be exaggerated. I have been pointing to this myself since the ’50’s, and am delighted to find such explicit agreement. I can only point out that my own advocacy has had no more lasting effect than Benezet’s. You will find some of my views of this aspect in my 1959 paper . . . (Arons 1959) . . . on the Amherst course. . . . It is worth noting that what Benezet was doing 70 years ago could now be done even more effectively because of the existence of excellent science and social studies curricula . . . (Arons 1993, 1997, 1998) . . . that would provide rich opportunity for invoking and applying just the kind of thinking, reasoning, and interpretation that Benezet was advocating and for which he had to invent his own illustrations. [emphasis added]

Consistent with Arons’s emphasis, Appendices I and II provide post-1930’s resources and references, respectively, that may assist a Benezetian overhaul of K–12 science education. Many of the listed items are taken from Hake (2000a), which has even more resources and references.

Quantitative assessment could include various ‘Classroom Assessment Techniques’ (NISE 2001) and diagnostic tests of conceptual understanding (Hake 2001b, NCSU 2001). Unfortunately, there are,
Table 4. Physical science portion of the National Science Education Standards
(National Research Council 1996a, Table 6.2, p. 106).

| Grade | Physical science standards |
|-------|-----------------------------|
| K–4   | Properties of objects and materials.  
       | Position and motion of objects.  
       | Light, heat, electricity, and magnetism. |
| 5–8   | Properties and changes of properties in matter  
       | Motions and forces  
       | Transfer of energy |
| 9–12  | Structure of atoms  
       | Structure and properties of matter  
       | Chemical reactions  
       | Motions and forces  
       | Conservation of energy and increase in disorder  
       | Interactions of energy and matter |

as far as we know, few research-based diagnostic tests for the measurement of science understanding in grades K–10.

7 So what?

Sixty years ago, in a small New England mill town, a creative superintendent made mathematics meaningful for students. Students today still leave traditional mathematics and science classes with almost no conceptual understanding of the subjects and little ability to solve real-world problems. For too long the pioneering experiment of Benezet has been ignored by the education community.

We hope the reader will forgive the length of following quotation, which describes teaching that we all can admire. Berman attended a demonstration lesson in which Benezet taught one of the experimental classrooms:

...the children were on their feet every chance they could possibly get to tell all they knew. They were free to think and, indeed, made the most of every opportunity. One could see mental expansion in actual operation, and also observe satisfactions register, when accredited with right answers or worthwhile opinions[,] for every second brought something to challenge their interests, and which they had to reach high to get. The teachers present saw no parasites but rather children who were taking a delight in independent intelligent thinking. These children were very much alive and their was not a single instance of a child being self-conscious or wishing to be over-looked. These children were free and unhampered by formal procedure and were finding themselves a part of the great world and scheme of things in which their knowledge and opinions mingled with those of older folks. They were transmitting and acquiring knowledge, and by means of directed guessing, when in doubt, were developing judgment. These children of a sixth grade were, indeed, laying the foundation for worthwhile thinking and judgment which is so essential to intelligent citizenship.

These active and thinking individuals not only transmitted and received knowledge but also lived
and felt the things they talked about because they were being brought up on Mr. Benezet’s formula for intellectual curiosity. [emphasis original] (Berman 1935, p. 50)

So YES! It is time for a science counterpart of the Benezet–Berman math experiment of the 1930’s. Why not give it a try in your classroom?

8 Acknowledgements

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10 Appendix I

Resources for a Benezetian overhaul of K–12 science education.

(A slash '/' occurring outside a URL ⟨…⟩ means ‘click on the following text’.)

AAHE’s CASTL (2001). Carnegie Academy for the Scholarship of Teaching and Learning, Programs for K–12; online at ⟨http://www.carnegiefoundation.org/CASTL/k-12/index.htm⟩.

AAPT’s Physical Science Resource Center ⟨http://www.psrc-online.org/⟩.

Active Learning Problem Sets (ALPS) ⟨http://www.physics.ohio-state.edu/~physedu/people/vanheu/index.html⟩.
Active Physics (http://www.psrc-online.org/) /Curriculum/High School/Comprehensive Curriculum/; also (http://www.its-about-time.com/htmls/index3.html).

ActivPhysics (http://www.physics.ohio-state.edu/~physedu/people/vanheu/index.html).

Alive Education.net (http://www.alincom.com/educ/sci.htm) ‘Excellence in Internet Education’.

The Coalition for Education in the Life Sciences [CELS], a ‘national coalition of professional societies in the biological sciences that have joined together in an effort to improve undergraduate education in the life sciences’ at (http://www.wisc.edu/cels/).

Comprehensive Conceptual Curriculum for Physics (C3P) (http://www.udallas.edu/physics/).

Constructing Ideas in Physical Science (http://cipsproject.sdsu.edu/). See also (http://learningteam.org/) /CPU.

Cooperative Group Problem Solving (http://www.physics.umn.edu/groups/physed/).

Dewey web sites: (a) by Craig Cunningham (http://cuip.uchicago.edu/~cac/dewey.html). (b) Center for Dewey Studies (http://www.siu.edu/~deweyctr/). (c) Hoover’s Teacher Ed Pages – Links to the World of John Dewey (http://www.cisnet.com/teacher-ed/dewey.html)

Educational Development Center (http://www.edc.org/). ‘Founded in 1958 when a group of scientists at the Massachusetts Institute of Technology joined forces with teachers and technical specialists to develop a new high school physics curriculum, PSSC Physics.’

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Exemplary & Promising Science Programs. US Department of Education. (http://www.ed.gov/offices/OERI/ORAD/KAD/expert_panel/newscience_progs.html).

Experiment Problems (http://www.physics.ohio-state.edu/~physedu/people/vanheu/index.html).

The Exploratorium Institute for Inquiry (http://www.exploratorium.edu/IFI/index.html).

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Logo Foundation (http://lcs.www.media.mit.edu/groups/logo-foundation/index.html). According to Harold Abelson, ‘Logo is the name for a philosophy of education and a continually evolving family of programming languages that aid in its realization.’

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Physics Instructional Resource Center (http://pira.nu/).
Physics Resources and Instructional Strategies for Motivating Students (PRISMS) (http://www.prisms.uni.edu/).
Physics Teachers Resource Agents (PTRA) (http://www.aapt.org/programs/ptra/ptra.html).
Powerful Ideas in Physical Science (http://www.psrc-online.org/) /Curriculum/College–University /Pre-service Teacher Education.
SEPUP Modular Materials (http://www.lhs.berkeley.edu/SEPUP/general.html). For a discussion see Wilson & Davis (1994), pp. 205–210.
Science Activities Manual: K–8 (http://www.utm.edu/departments/ed/cece/SAMK8.shtml).
Science Helper K–8 (http://learningteam.org/):
Funded by the Carnegie Corporation of New York, and created by a team of leading teachers, specialists, and administrators, Science Helper K–8 CD-ROM offers 919 lesson plans which are the culmination of 15 years of development, field-testing and refinement. The lesson plans represent seven of the most effective and influential science curricula ever written – COPES, ESS, ESSP, MINNEMAST, SAPA, SCIS, and USMES. You can easily locate the lesson you’re looking for by grade level, subject, process skill, keyword or content... then print it out. All in all, Science Helper is the single most effective, most comprehensive way to expand your K–8 science program immediately.
Socratic Dialogue Inducing (SDI) Labs (http://www.physics.indiana.edu/~sdi).
Tools for Scientific Thinking (http://www.vernier.com/cmat/tst.html).
Tutorials in Physics (http://www.phys.washington.edu/groups/peg/tut.html).
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11 Appendix II

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Contains essays by researchers in education and by historians of more rapidly developing institutions such as power systems, communications, health care, and agriculture. Sets out to answer a challenge posed by Kenneth Wilson:

If other major American ‘systems’ have so effectively demonstrated the ability to change, why has the educational ‘system’ been so singularly resistant to change? What might the lessons learned from other systems’ efforts to adapt and evolve, have to teach us about bringing about change – successful change – in America’s schools?

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Physics is difficult in the same way that all serious intellectual effort is difficult. Solid understanding of English literature, or economics, or history, or music, or biology or physics
Benezet–Berman mathematics teaching experiment does not come without hard work. But we typically act on the assumption (and argue to our principals and deans) that ours is a discipline that only a few are capable of comprehending. The priesthood syndrome that flows from this assumption is, regrettably, seductive…If physics is not more difficult than other disciplines, why does everyone think that it is? To answer indirectly, let me turn again to English. Six-year-olds write English and (to pick a skilled physicist writer) Jeremy Bernstein writes English. What separates them? A long, gradual incline of increased ability, understanding, and practice. Some few people, illiterates, do not start up the hill. Most people climb some distance. A few climb as far as Bernstein. For physics, on the other hand, we have fashioned a cliff. There is no gradual ramp, only a near-vertical ascent to its high plateau. When the cliff is encountered for the first time by 16- or 17-year olds, it is small wonder that only a few have courage (and the skill) to climb it. There is no good reason for this difference of intellectual topography. First-graders could be taught some physics…(Hammer 1999)…, second-graders a little more, and third-graders still more. Then for the eleventh- or twelfth-grader, a physics course would be a manageable step upward. Some might choose to take it, some not, but few would be barred by lack of ‘talent’ or ‘background’. [Our italics.]

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If good materials are to be used, we must bring them to the attention of teachers and administrators. Our two year search, unfortunately, has led us to say that the available text books are not the tools that will effect a change in the way physical science is taught in the middle schools of the United States. [emphasis added]

With seeming inconsistency, Raloff (2001) reports that

...Hubisz...would have liked to include the book...Haber-Schaim et al. (1999) – an ‘available’ textbook...in his recent review of science texts ‘because it would have allowed us to say something really positive.’ But since it was not among the top dozen sellers, it didn’t make the cut.

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Common to the origin of many of these...(newer science education programs)...is funding from the NSF. Explains Janice Earle, a senior program director... (at NSF)...qualifying projects must now exhibit ‘a coherent content...aligned with national standards’, foster critical thinking and problem solving, and be grounded in research on how children learn. Moreover, NSF recommends that any new curriculum be developed by teams of practicing scientists, engineers, and mathematicians, along with classroom teachers. ‘I would be surprised if most textbooks were developed like that,’ Earle says. They aren’t. One exception, however, is (Haber-Schaim et al. 1999)...notes Uri Haber-Schaim, one of this textbook’s authors. Launched in 1967, the book briefly became a top selection for eighth- and ninth-grade classrooms. Developed with NSF funding, the book was initially issued by a big publisher, but sales dropped when newer texts entered the field. In the early 1990’s, the company decided not to publish further editions but permitted Haber-Schaim to pick up rights to the book. His firm, Science Curriculum Inc. of Belmont, Mass., now produces it. Unlike other science texts for early adolescents, Haber-Schaim says, ‘we very thoroughly
field-tested our experiments in classrooms over a period of 2 years. We even field-tested every homework question... (Among extollers)... of the book is John L. Hubisz... He would have liked to include the book in his recent review of science texts... (http://www.aapt.org) ‘because it would have allowed us to say something really positive.’ But since it was not among the top dozen sellers, it didn’t make the cut.

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