## **Physics for first-graders?**

David Hammer <davidham@physics.umd.edu> Physics and Curriculum & Instruction. University of Maryland at College Park College Park, MD 20742

This is a preprint of an article accepted for publication in *Science Education*,© 1998 John Wiley & Sons, Inc.

\_\_\_\_\_

Last year, browsing current journals, I came across an article in *Kappan* titled "Physics for First Graders" (Hagerott, 1997). I'm a big fan of the idea that young children can, do, and should learn physics, even children as young as the first grade. But this article was misguided, and it troubled me that *Kappan*, which bills itself as "The Professional Journal for Education," would publish it. I held off writing a response — I had plenty to do, and I assumed there would be a barrage of criticism. Still, I watched *Kappan*, and when several months went by without any sign of that criticism, I phoned the editors to learn that none had been submitted.

Was everyone expecting someone else to write? More worrisome was the possibility that the piece fit with *Kappan* readers' expectations of science education. I drafted a somewhat longer essay than I'd originally considered, backing up a little to explain my concerns about the scientific substance and pedagogy.

*Kappan* declined to publish my response. The editors felt I was "eminently unfair" to the author. Moreover, they noted, no one but me seemed to have any problem with the article: "As an enrichment activity that will give kids more exposure to some of the basic concepts of physics than they are likely to get otherwise — unless they have an exceptional first-grade teacher — we see nothing wrong with [the author's] approach." I don't think I was unfair, and the fact that the editors and readership might see nothing wrong with "Physics for First Graders" was, in the end, what motivated me to write. It is also what motivates me to publish my essay here, and I am grateful to *Science Education* for providing a venue.

What follows is the essay I submitted to *Kappan*. Readers of *Science Education* may make their own judgments, and I would be happy to hear them.

## **Physics for First-Graders?**

Physics for First-Graders (Kappan 78, 9, pp. 717-720) reminded me of a moment fifteen years ago with seven-year-old girl I'll call Rachel. I was tossing a toy airplane, making it turn loops in the air, and Rachel was watching, very impressed. "Why do you think it does that?" I asked her. Rachel, who had just finished first grade, beamed with the answer, "It interacts!" I don't know what I was expecting to hear, but it certainly wasn't that. "It interacts!" I repeated back, "Wow! What do you mean?" "It interacts!" she tried again, a little less brightly. "Wow, Rachel. Where did you learn that?" "In school."

I'm sure Rachel had enough knowledge and experience to think about the plane in a meaningful way, but I was at a loss over how to get her to do that. My question, on top of whatever she had learned in school, lead her instead to invoke the word "interacts." I asked what she meant, and I found out she didn't mean anything. "Interacts" was, to her, a word to use when answering questions in science, the way "please" is a word to use when making requests.

I have never taught elementary school, not then and not since. If I had, I might not have been at a loss. I probably wouldn't have started the conversation as I did. "Why" questions can be hard to understand as questions for students who are new to science, even older students — my experience is with high school and university students taking introductory physics. Much of what they need to learn is what makes a good explanation, and, at the beginning, "why" questions tend to leave them dependent on the teacher for corroboration. ("What will happen if..." questions are easier to understand, so I might have been better off asking Rachel something like, "What will happen if I bend these flaps back further, like this? Do you think the plane will fly in a bigger loop or a smaller one?")

Unfortunately, those of us who work with older students often see them responding to physics the same way Rachel did, as if it were magic words and wizardry. Expecting little or no connection to their own intuitions about the physical world, they neglect their common sense, often to the point of absurdity. Somehow they have learned that science does not make sense, except perhaps to scientists.

Physics for First-Graders recounts the author's experience as one of a group of 20 engineering students from a major university who volunteered to teach science in local elementary schools. One of the first things he did with his first-graders was to bring them out to a playground and have them hang from the "monkey bars," with and without backpacks full of books. "Why," he asked them, after giving them the experience, is it harder to hang on to the bar wearing a backpack?

They offered bits of commonsense logic, such as "The books make you heavier." But they never quite hit the mark.

"The reason why you fell down and why it was harder for you to hold on with the backpack was" — I paused momentarily to add more drama — "gravity!" I sounded like Beakman. "Gravity pulls things down, and gravity is what makes things feel heavy. Remember this word, because you're going to hear it every time I am here — gravity," I concluded proudly. (p. 719)

Here was a moment that might well contribute to students' learning that a scientific explanation involves "scientific" words, not common sense. Moments like this are probably typical enough that, over the years, students can be convinced that science is a mysterious enterprise.

A few months before reading this article, in fact, I had observed a similar moment at a fifth birthday party for one of my son's friends, held at a place aptly titled "Weird Science," where a man in a lab coat held the children rapt with a series of demonstrations. In one, he showed that he could not push a water-filled balloon into a glass beaker. He explained that the reason it wouldn't go in was that the air in the beaker getting in the way. He asked the children for ideas what to do, to get the balloon in the beaker. "Get the air out!" guessed the guest of honor. "Close," said the Weird Scientist, but the real answer was a magic word. "We have to use energy."

He then lit a candle inside the beaker. The candle burned for a moment and went out; when it did he put the balloon back on the mouth of the beaker and it soon plopped right inside. The candle, he explained, with his authority as a Scientist, "made energy," and that explained how the balloon got in.

"Get the air out" was not only a perfectly logical idea, and worth supporting for that reason alone, it was also correct: That "energy" from the candle warmed the air in the beaker, causing it to expand and some of it, yes, to leave the beaker. As an explanation of the demonstration, of course, it was not complete, but then it was coming from a five-year-old. Coming from anyone, to my mind it's a better explanation than "energy," just as "it makes you heavier" is a better explanation than "gravity" for why it's harder to hold on to monkey bars wearing a backpack full of books.

Certainly it is well that students find science entertaining and scientists amiable. But teachers who do not recognize and work with the sense of students' "correct" reasoning are not likely to work with the sense behind "incorrect" reasoning, either, and it can't be long before students learn that their sense and reasoning have nothing to do with it. Some of the more headstrong children may choose to dismiss the teachers' dismissal of their ideas; perhaps these are the children who can go on to learn science.

Reading *Physics for First-Graders*, like watching the Weird Scientist, was disturbing in a familiar way, similar to what I'm sure I would have felt watching the author, in the episode he remembered from his childhood, plugging a speaker into a wall outlet. This fellow doesn't know what he's doing, and he's liable to do some damage. I thoroughly agree that "physics and other scientific knowledge can be taught to third-, second- and even first-graders. It can be taught appropriately to anyone." But scientific knowledge is much more than the traditional image of "concepts," and determining what is appropriate physics for first-graders is not trivial.

Also disturbing, and also familiar, is the fact that the administrators of the program at the university would decide to put a group of engineering students "in charge of three hours of instructional time per week," with no more than a "teaching module . . . as a guide to those . . . teaching fourth-, fifth,-, and sixth-graders," and, "no direction" whatsoever for those teaching younger children. It reflects a naive but broadly held disrespect for the profession of teaching.

What is not familiar is to see this disrespect displayed in a prominent publication for educators. I do not fault the author: He was new to thinking about science teaching, in a context that inspired presumption, and his intentions and enthusiasm were sincere. I would welcome *Physics for First-Graders* as an early paper in a science education seminar, hoping to see more sophistication later in the semester. But I cannot fathom the decision at *Kappan* to publish the ingenuous impressions of a novice, as if they represented an important contribution to the community. The "Professional Journal for Education" should have more respect for the profession.

## Acknowledgements

I am grateful for supportive feedback on this essay from a number of people, especially Al Cuoco, Paul Goldenberg, Marion Reynolds, and Deborah Schifter.

## References

Hagerott, S. G. (1997). Physics for First Graders. *Phi Delta Kappan*, **78** (9), pp. 717-720.