

OPINION

No Kid Should Know That Much about . . .

Henry J. Frisch

Answer the following four physics questions correctly and you may qualify for the next round of the prestigious Academic Decathlon:

1. How is the emission of photons responsible for visible light?
2. The loss of static electricity off an object is an ____ (fill in the blank).
3. What is the only energy-to-matter conversion known in the universe?
4. What is the opposite of an electric motor?

These questions come from a workbook for the Academic Decathlon, a nationwide competition for high school students. I was asked by a student at a large urban high school in Chicago to help his team prepare. The “physics” questions were baffling them, and their coach, a talented English teacher, was also having a hard time. It’s no wonder, given questions like the above. In the process of working with the group, I and a number of the physics students and post-docs at the University of Chicago learned how much a little contact with professional scientists can mean to the students and teachers—in particular, the building of confidence in their own common sense and intelligence in the face of pervasive negative feedback.

Here are a few other examples of the problems that bright, curious kids face in today’s urban schools.

C., an eighth grader

I met C. through Lourdes Monteagudo, director of the Teachers Academy for Mathematics and Science (TAMS), an independent not-for-profit organization founded to improve math and science education in Chicago’s public schools. Lourdes had just come back from an eighth-grade graduation in one of the roughest neighborhoods in Chicago, and she had been bowled over by the speech of the valedictorian. That was C. I asked to meet the young man and was also impressed. I hired him for the summer to work on CDF, the Collider Detector at Fermilab.

C. comes from Chicago’s Far South Side, a neighborhood perhaps best known as the home of “Yummy,” the

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14-year-old who shot a younger boy on orders from his gang leaders. I would often find C. in my lab late at night doing homework; he said it was easier to go home after everybody was asleep.

C. easily taught himself how to use a modern digital Tektronix scope by finding the user manual on the Web. After his summer, C. decided to do a science fair project based on work he had done with me on cross talk in the long cables (containing ten sets of twisted pairs) that we use in the trigger electronics for CDF. We had engineered the cables to have a relatively high impedance. The question was how much cross talk takes place between individual pairs.

But when C. presented his idea to his science teacher, the teacher said, “What do you know about cross talk?” C. gave the teacher the summary report he’d written on the subject, whereupon the teacher told him, “No kid should know that much about cross talk,” and refused to let him submit the project to the science fair. The teacher told C. he “had an attitude.”

D., a fourth grader

For a number of years, I used to invite local fourth graders to the University of Chicago for a “Lecture Demonstration Spectacular,” a tradition started by Hellmut Fritzsche when he was chair of the physics department.

One of my demonstrations was to roll two cans of soup, one containing pea soup, the other beef bouillon, down an inclined plane. I’d first ask the students which can they thought would roll faster. The majority would vote for the pea soup, as it was “heavier.” We’d then do the experiment, and, lo and behold, the bouillon would win. I’d then show them that it had nothing to do with being heavier. Taking a wooden hoop and a wooden disk of the same diameter and weight, I’d then ask which would go faster—a harder question, usually with no clear consensus. In the rolling test, the disk would win handily. “See?” I would tell them. “It’s like the soup.”

One year, well after I’d finished the two demos, a little pudgy black kid in the front row raised his hand. “I have a question. You said that the disk won because it was like the soup, but the pea soup is like the disk and the bouillon is like the hoop. I don’t

understand what you meant.” This kid had sat there for 45 minutes puzzling over what he’d seen before raising his hand. In the best tradition of science, he had challenged me, and he was right. But his teacher didn’t see it that way. She immediately silenced the boy and then apologized to me (in front of everyone). The boy clearly “had an attitude.”

To be continued

Such experiences are not atypical of what a lot of bright kids go through in our urban schools. Here are some of my more general observations about how each of us can help with a small investment of our time.

▷ I like working with third and fourth graders. They are still curious, and their real scientific instincts for thinking, asking, testing, and observing haven’t yet been beaten out of them. The vast majority of these students can learn science, and it’s in the earlier grades that they are programmed to do well or poorly in math and science; high school is important, but cannot succeed if the elementary schools fail.

▷ Keeping kids from being done in as they grow older is much harder. It’s not a question of curriculum alone (although having a curriculum teachers are comfortable with is essential). A critical problem is the occasional bad teacher. Kids are proud, and, from watching my own, I know they won’t play a game in which they’re set up to lose. One year of a teacher who is on a student’s case can be enough to undo the work of many good teachers. We need to reeducate those teachers who attack a curious child’s self-esteem, so that they instead encourage curiosity and risk taking.

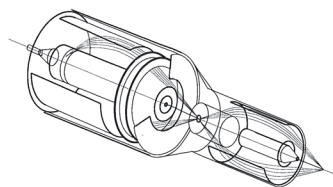
▷ Ideally, tests that require a student to simply memorize the expected answer should have no place in what we teach when we are trying to teach physics. The reality is that such test-taking skills are rewarded, as students at wealthy suburban and private schools know. But we should not be too proud to teach kids to spot baloney when they are fed it. We should, of course, also work on the menus.

▷ What science is is a mystery to most teachers. Almost all of the 17 000 elementary school teachers in Chicago teach math and science on a regular



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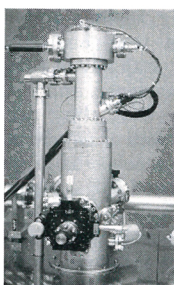


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(at least weekly) basis. The emphasis is on memorizing names; science is seen more as a body of knowledge than as a mix of curiosity and method. Teachers consequently avoid it, and their uncertainty is transmitted to the students. But as some innovative programs have shown, quantitative work mixed with curiosity-driven questions can really turn kids on.

▷ At a joint meeting of the American Physical Society and the American Association of Physics Teachers, it was stated that “we do not know how to deal with the problems of math and science education in big urban schools.” But I truly believe we *do* know many if not most of the ingredients of these problems, and have working models for how to confront and solve them. Solid numbers from TAMS show that there are methods to change how math and science are taught that work on the scale of the 400 000 students in the Chicago public school system. If every physics graduate student, postdoc, and faculty member made regular visits to local schools, we could have a big impact with a rather small investment of time. We need to move as a community away from a narrow view of these problems to dealing with them on a large scale.

It made a big difference to the students at the high school I visited to learn that I had as much trouble as they did decoding questions such as the ones above. The students were bright and inquisitive, but their confidence had been shaken. They were relieved to learn that it wasn't them but instead fuzzy questions that were to blame. On the first visit, I brought along a physics undergraduate who

had competed in the decathlon during high school. She talked to the girls at length, telling them that women can and do go to college and major in science and pursue scientific careers. As we were leaving, one of the students told me that we were the first scientists they had ever seen at the school.

By the way, the “correct” answer for question 3 above is “cosmic rays.” This is a good example of what passes for science education in many classrooms: It combines misinformation (the question ignores a major field of physics) with fuzzy thinking and language. Why are cosmic rays a conversion? More basically, what level is the question on? Is it referring to pair creation? What does the word “conversion” mean? Because the emphasis is on blind memorization rather than understanding, it leaves no room for questions, it teaches nothing. We can (and should) work on improving curricula and teaching materials, but there is no substitute for having working scientists in the classroom to help students and teachers use their common sense and mother wit to explore the real questions behind the words. And that is something all of us can help with. ■

For Further Information

Details on the Teachers Academy for Mathematics and Science are available on the Web at <http://www.tams.org>. An example of an innovative curriculum development project that's been successful in Chicago is Teaching Integrated Math and Science (TIMS), directed by Howard Goldberg and Philip Wagreich; <http://www.math.uic.edu/IMSE/>.

