



Teaching Physics

When I was in the second grade in Akron, Ohio, my teacher was Sister Mary Zita, Servant of the Immaculate Heart of Mary, otherwise and always known as IHM. At the end of World War II the teaching of students in a Catholic school melded the basics of standard elementary school teaching with that special quality of guilt and pious menace that only a nun can evoke in her charges.

The reason that Sister Zita stands out while other IHMs have disappeared from my memory is that our second grade class took part in a series of diocesan experiments on teaching science in elementary schools. Our participation got us recognition at St. Mary's and a bus trip from Akron to Cleveland—a monumental journey for most of us.

During our science classes, Sister Zita would teach some aspect of science and then every few minutes she would stop and ask “Are you thinking of a good question now?” The idea behind this approach, near as I can extract it from my memory of so many years ago, was that the collective questions of our classmates, prodded by these incessant requests, would provide guidance to our teacher as to the barriers to a seven year old's understanding of a scientific principle and to get us thinking about the topic at hand.

My memory, perhaps filtered through all this time, was that this was an odd thing to do. And my response was that if I had a question I'd ask it. But then, I was always in a lot of trouble in grade school because when the class was working I was forever going up to the nun's desk to ask her how she liked my latest idea. I did it to such an extent that my mom told me once that the nuns called me “The Floorwalker.”

I don't think the problem of teaching elementary school science was solved in the Catholic schools of the Cleveland archdiocese and it hasn't been solved today. Even if the good nuns and brothers did make a dent in the problem, it, like a virus, is present in a mutated version. We docile darlings of 1945 have been replaced by the media-aware, distractable preadults of today.

Although it is assumed that all faculty members in the physics department of a modern university teach the basic

physics sequence, the reality is that the pressures on newly acquired professors to establish a funded laboratory are such that most of them either negotiate or buy out of their teaching obligations. Thus, much of the teaching of basic physics courses is done by those no longer doing research or those hired to take on a task that some regard as onerous and unfulfilling. In institutions such as Georgia Tech the sizes of these classes tend to be well over a hundred students. The ideal of a college education was expressed by President James Garfield as Mark Hopkins, the president of his *alma mater*, Williams College, at one end of a log and an intelligent, curious student on the other end. These days this is no more than a faint wish.

The reality, taken from teaching Physics I this past fall, is that you are faced with 120 students, during the first week of class. After that the attendance dwindles to about one quarter of that for an ordinary lecture, but increases to twice that size the day before a quiz. Although I have no hard evidence, it appears that those who attend class do a bit better than the others. But some, without benefit of my carefully crafted lectures, do very well on their quizzes and finals. This is not to say that the lecturers do not make a difference. Some profs do consistently better by a few percentage points than others and some classes do worse, even when the course schedules are taken into account.

We try to devise methods that will increase our students' involvement in the material that we are teaching. One recent addition to the assignment of physics problems has been the use of the Web. At Tech we use WebAssign, a problem assignment, entry, and reporting service based at North Carolina State University. The service inputs almost all of the problems from popular physics textbooks and faculty at any school can then assign these problems to their students. The WebAssign service posts the problems and individual students log on and attempt to solve the problems. The faculty member can set the number of tries, the time allowed, and the type of feedback the student receives after they have entered their answers. The grade for each problem set is recorded and used as one part of the final course grade.

As with most efforts these days, particularly in the field of computer-assisted teaching, the results are a mixed bag. It is, I believe, better than having no assessment of the problems that were assigned to large classes previously.

But when I look at the near-random scribbles of some students on their quizzes, I despair. For the third or so who write down their solutions, I feel that something has been transmitted across the space between the lecture table and lecture hall seats. But for the rest, the solutions of problems of a real physical world are as haphazard as a throw of a dart at a campus hangout.

For many of these students, it would appear WebAssign has been defeated by a dose of mutual support by fellow students who help them while they are signed onto WebAssign. One of my students told me that he overheard another student on her cell phone taking step-by-step instructions from someone across campus. To combat some of this unpermitted collaboration, two weekly, hand-graded problems were also assigned. The problems were more complicated, and required students to show all their work. Even here, some of my class got caught copying from each other.

Besides teaching the basics that describes how the natural world works, professors of science courses are charged with teaching how to solve technical problems, just as teachers of literature are supposed to teach writing and critical thinking. But in most instances our work results in very little beyond those who are receptive to those ideas. Yet, it is the understanding of how to break down a problem into subproblems, draw a diagram, if necessary, identify the given parameters, and establish an approach to determine the unknown values that will lead to the solution of the problem. That we do not do as well as we would like.

Assigning homework problems is just one approach to give students practice with tools for the analysis and so-

lution of problems that they will confront in their profession. But it is not the only approach. There has been, over the past three decades, a substantial amount of research dedicated to teaching physics. A number of approaches have been identified as useful and some have been tried at Tech. The results, as with WebAssign, are mixed. But even those that show promise, if continued, always come up against the sheer numbers of students we must teach. It makes it impossible to establish any new consistent teaching approach beyond WebAssign. And it is not a proven method, just a more efficient mechanism for assigning and grading problems.

What is missing is some way of assessing where a student fails in his or her approach to understanding the physics and problem solving. And not having this information, it is impossible to tell that student such things as: "No you can't just apply the equation in the book, you need to calculate something else beforehand." The question is: how can you get inside a student's mind?

During my lectures I stop every so often and ask if there are any questions on the material being discussed and then I count to ten because it takes some time for a student suddenly confronted by the question to formulate one of their own. But even this may be a little too abrupt. Perhaps what I ought to do is to take my PowerPoint presentation of the material for the day's lecture and insert after every fifth slide, Sister Zita's query: "Are you thinking of a good question now?"

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