On Buckets and Fires

Herbert S. Wilf

I appreciate the opportunity to visit my prejudices about mathematics education upon the world.

For many years now I have watched while committees, or projects, or individuals have debated their ideas about curricula, for primary education, for secondary education, for colleges and universities, and so forth. I have more than once made a mental analogy of these developments with various diets. Would you like the Atkins curriculum or the South Beach? The low fat or the high protein? The curriculum du jour is a constantly shifting target, but everyone agrees that the situation is getting more and more dire. We say that our students are not learning mathematics. We worry that we are not following the model of China, or Korea, or some such, and we debate whether that’s a good thing or a bad thing. We think we had better use calculators in the classrooms, or perhaps we should forbid calculators in the classrooms, but we should certainly think carefully about that subject.

Over the years I have become more and more certain that these curricular discussions are somewhere between irrelevant and marginal. Much more important than what students are being taught, at least until the years in which they have chosen a major subject, is by whom they are being taught and how. For education is a supremely human-to-human process. You cannot just lay out the goodies on the table. That will not stimulate student appetites.

It has been said (perhaps first by Plutarch) that “A mind is a fire to be kindled, not a bucket to be filled.” The job of the teacher is to light that fire—never mind whether the student is learning the multiplication table or studying quadratic equations. The subject matter is only the fuel. The teacher lights it up.

The earliest years in the education of an individual are those in which the teacher’s human qualities are the most important. As the individual finishes secondary education and enters college, it seems reasonable that the curriculum should become somewhat more important. So my remarks here apply more often to secondary education than to college. However, I have seen in my own office many undergraduates who enter their freshman years propelled like rockets toward particular careers—medicine, the law, computer science, whatever. My advice to them has always been the same: “Cool it. You are a student in one of the great universities of the world. You can study medicine later. For now, try archaeology, Sanskrit, art appreciation, mathematics, etc., all of which are available in abundance here. Make your choices based on who will be teaching the various courses. Sign up for the ones that have stellar teachers. Don’t worry about what they’re teaching. Just listen, think, and enjoy.”

To improve the quality of mathematics education, we need to enhance the abilities of teachers to inspire students. We do not need to rearrange the deck chairs on our curricula, if you’ll excuse a mixed metaphor.

How to do that?

Primum non nocere; first, do no harm. A great deal of harm is inflicted upon young students whose confidence in their mathematical abilities may be fragile. Teachers who themselves feel mathematically challenged sometimes resort to making students feel worse in order to make themselves feel better. Fixing this problem means, above all, making sure that those who teach mathematics know mathematics. As a rough rule of thumb, the
teacher should know enough to be able to field a question from a student, a follow-up question from another student, and a third question that goes still deeper. Depth of knowledge is the best security that the teacher can have, the best insurance against his/her trying to put down bright students, and the best route to lighting that fire. So, you want a good mathematics teacher? Make sure he/she knows a whole bunch of mathematics.

When people find out what I do for a living, a very frequent response is “oh, my worst subject”. We discuss this for a while, and it develops that a teacher somewhere back in the lower grades “made me feel stupid”, perhaps in public, and this flipped his/her mathematics switch permanently to the “Off” position. Public humiliation is a very difficult experience to get past.

Here are a few examples of answers that teachers might give to student questions that have the effect of deflating the self-esteem of a student and discouraging a student from asking more questions:

• “You just have to substitute … into …” [Just?]
• “Where were you when I told the class that …?”
• “I covered that point last Wednesday. Here is what I said …”
• “That fact is a trivial consequence of …”
Well, you get the idea.

To inspire a student, a teacher must exemplify the kind of person that the student would like to be. Most of us would like to be happy in our work. An inspiring teacher must be happy in her work. In this case, since the subject is mathematics, the teacher must enjoy mathematics. If that’s not the case, the students will see through her in one nanosecond and lose interest in the teacher and the subject. That leaves one small question—how can we get more teachers who enjoy mathematics? That’s a tough one, but please let’s work on it. It’s very important.

Perhaps the attribute of being inspiring is itself teachable to some extent and not entirely genetically encoded.

Perhaps in the process of training teachers we might require them to study some branch of mathematics that is entirely new to them, just to instill in them a feeling for the difficulty of learning a new subject, so they’ll have more empathy with their own struggling students.

Our quality of education will improve when we have more teachers who are knowledgeable in their subject and who enjoy doing it and talking about it. This has all been said before. I claim no originality here. But I do claim that these obvious truths have made a deep impression on me, and I very much hope that we can work together to create the inspirational educational system that our children deserve.

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