Letters to the Editor

More on Wilf-Zeilberger Pairs

In re: "What is a Wilf-Zeilberger pair" in *Notices of the AMS*, Vol. 57, No. 4, April, 2010, pp. 508–509.

Studying the first appearance of an idea can be of a considerable help in fully understanding and appreciating the idea's later generalizations and elaborations. The wellspring of the Wilf-Zeilberger pair is particularly illuminating and inspirational. It is a pity that it wasn't mentioned in Further Reading. The seminal paper is discussed at length in the first entry in Further Reading and given below.

Fasenmyer, M. C., A note on pure recurrence relations, *Amer. Math. Monthly* **56** (1949), 806–812.

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Mathematics and Traffic Control

Every time I drive to Stamford, here in England, I seem to be caught with the road barriers down to enable the trains to pass on their way to Scotland. They are reputed to be "down" 80 percent of the time! A great trouble to cars.

As I sit there I wonder how much it is costing in terms of driver salary, sitting there waiting.

As I sit the queue builds up, and when the gates are raised the queue slowly dissipates from the front. The back can still be building up. Sometimes the queue can be one mile long.

Is there a simple way of measuring the "total time spent by drivers waiting over a day" without having to record each and every car arriving, moving, and then getting through the barriers?

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Revolutionary Implications

I totally agree with the sentiments expressed in Underwood Dudley's article "What is mathematics for?". The situation is actually a lot worse than he expresses in his article.

Vivek Wadhwa has described how there's no shortage of scientists and engineers (see: http://www.businessweek.com and search for "science education myth"). I've been concerned with what skills those who are working as scientists and engineers actually use. I find that the vast majority of scientists, engineers, and actuaries only use Excel and eighth-grade-level mathematics. This suggests that most jobs that currently require advanced technical degrees are using that requirement simply as a filter. In particular, I'm working on documenting the following:

Math Myth Conjecture: If one restricts one's attention to the hardest cases, namely, graduates of top engineering schools such as MIT, RPI, Cal Tech, Georgia Tech, etc., then the percent of such individuals holding engineering as opposed to management, financial, or other positions and using more than Excel and eighth-grade-level mathematics (arithmetic, a little bit of algebra, statistics, and programming) is less than 25 percent and possibly less than 10 percent.

This is a conjecture that desperately needs resolving with solid statistics and in-depth interviews. If it holds up, the educational implications *should* be revolutionary.

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Is Algebra Really Useless?

Thank you for Underwood Dudley's provocative "What is mathematics for?" in the May 2010 *Notices*. Given how convincingly he explained why almost everyone finds algebra useless (the set of mathematicians has measure effectively zero), I was puzzled by his fondness for the admittedly artificial quadratic problem of the reneging investors. Then I saw his reason: require algebra because (resurrecting an old argument) the task of mathematics (education) is "to teach the race to reason".

He supports his argument with quotations that credit successful study of mathematics with later ability to reason clearly in law and other endeavors. Unfortunately, the citations demonstrate only correlation, not causation.

Even if we grant that acquiring "the habit of steadfast and accurate thinking" is the proper goal of mathematics education, it does not follow that we should emphasize algebra rather than genuinely useful mathematics that might train the mind at least as well. I wish everyone were taught enough elementary probability and statistics to recognize the prosecutor's fallacy. That's possible even without a formal statement of Bayes' Theorem.

If we must teach algebra to all, let's also incorporate spreadsheet instruction. Formulas that work with values in referenced cells help convey some of the essence of symbolic computation without calling attention to the abstraction that mathematicians love and students find mysterious. The logic is transparent: "what if" questions always have right answers, and the students learn a tool that they can actually use.

Finally, teach mathematics because, like music and poetry, it's beautiful. I've shown third-graders the Pythagorean theorem with several proofs by dissection. These are much more accessible, memorable, and gripping than the one I learned in high school that relied on the algebra of mean proportions.

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Too Much Math Rather Than Too Little

In "What is mathematics for?" in the May *Notices*, Underwood Dudley points out that in few occupations do the workers need any mathematics beyond arithmetic. Some twenty years ago I asked the same question and answered it with the aid of two books, *The Complete Guide for Occupational Exploration* and *The American Work Force*. The first one lists thousands of occupations and the levels of reading, language, and mathematics required in each one. The second tells how many people are employed in each occupation.

There were six levels of mathematics, which I summarize briefly as: 1) and 2) arithmetic; 3) some algebra; 4) algebra, geometry, trigonometry; 5) a year of calculus and some statistics; and 6) advanced calculus, DE, abstract algebra, statistics. Combining the data from the two books, I concluded that only three percent of the work force needed levels 5 or 6, while two-thirds required only arithmetic. Even so, The *Occupational Outlook Quarterly* advised: "Deciding how much high school math to take is easier if career goals have been established. However, it is better to take what may seem to be too much math rather than too little. Career plans change, and one of the biggest roadblocks to undertaking new educational or training goals is poor preparation in mathematics. Furthermore, not only do people qualify for more jobs with more math, they are also better able to perform their jobs."

For a more detailed analysis, go to the two sources I used or to the chapter titled "What's in it for me?" in my book, *Strength in Numbers*. [Editor's Note: This book was reviewed in the May 1999 issue of the *Notices*.]

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Humankind's Common Heritage

In his article (*Notices*, May 2010), Underwood Dudley argues that mathematics should be taught not because it is useful, but to develop the power to reason. He has a good point, but I think a third aspect of this discussion has been neglected: everybody should be able to appreciate the accomplishments of our civilization and learn how to regard them as humankind's common heritage. That is why one should read literature, learn science and history. Mathematics is part of that, besides also being indispensable as a tool for the natural sciences.

About the usefulness issue, I think he goes too far in saying that only arithmetic is really needed. Learning how to read a graph, understanding what a function is, and maybe knowing a little about probability may not be needed in the workplace, but it is required if one wants to become a full member of a modern society.

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Science Advocacy

This letter is in response to the Opinion column by Steven Krantz in the May 2010 *Notices*. First of all, it is terrific that the *Notices* is establishing an education column, and the stellar editorial board promises engaging and provocative contributions. Teaching is indeed an important "product" of essentially all mathematics departments, as Krantz's dean pointed out. The opinion piece begins by stating, probably correctly, that "The dean may have a vague idea of our scholarly presence, and perhaps a fleeting notion of what our research programs are about, but he is intensely aware of our teaching [...]" This statement points to an important problem mathematics departments face, being viewed in many cases as service departments without a significant research role.

The AMS maintains a Washington office, directed by Sam Rankin, that focuses on advocacy with the U.S. Congress and is very effective in making the case that mathematics is a key enabling discipline—and organizes events that showcase examples of the accomplishments in different scientific areas made with the help of mathematics. And it makes the case that the core mathematical disciplines form an important base for present and future applications. My own work on science advocacy within SIAM has certainly shown me how important advocacy is for the long-term well being of the mathematical sciences community.

Steven Krantz's assessment of the lack of appreciation of mathematics research within the higher administrations of universities tells us that we also need to engage in advocacy much closer to home. Every dean and every provost should be just as aware of our research programs and their significance for the larger goals of the institution as of our teaching mission. Department heads can very effectively benefit their department by engaging in advocacy within the university as a matter of course, and much can be learned from the activities of the AMS Washington Office. But to really be effective the department head will require the help of the faculty in order to develop an appropriate approach and amplify the message.

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