ON THE JOB MATHEMATICS

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What kind of course work is appropriate for a general education mathematics requirement? In most instances, students see a presentation of one or more mathematical topics followed by some applications. Sometimes these applications are characterized as 'real world' even though no person would ever be paid to work the problems that students are given. We will describe an approach to this issue that requires students to replicate mathematical work that is done by people who want to keep their jobs. Only a small minority can make money doing mathematics for entertainment. Hence, we omit for this category everyone employed in a mathematics department. On this account, our approach is, by necessity, an interdisciplinary one.

What kind of course work is appropriate for a general education (GE) mathematics requirement? The question has been asked numerous times in numerous venues and produced numerous answers [1, 2, 3].

On this occasion, we begin with a new, or perhaps recycled, objective for such a course: Let us try to convince the GE student that mathematics can be used to help make decisions in the workplace. Perhaps a commercial version is more compelling: Let us convince the GE student that employers will pay good money to someone who can do useful kinds of mathematics.

Now, what kind of course, exactly, will accomplish this end? The following exercise is often used as a prototype for what fails to pass muster: A man can walk 5 miles per hour, and row a boat 3 miles per hour. He wishes to make regular visits to his girlfriend who lives 2 miles upstream on the other side of a 300 foot wide river with a current at 1 mile per hour. How far up the river bank should he tie his rowboat so as to minimize time of travel?

An allegedly much better problem uses some data on yields of corn per acre in the US from 1890 to 1990. The student is asked to fit a curve to this data, thereby getting practice with polynomials or trigonometric functions or exponentials.

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Why is the second problem better? Presumably because it contains some real data, while the first does not. Recognizing this fault, can we repair the first problem? Suppose we name the two principals (real names, say, using volunteers from the class). We can also name the river, say, the Pamunkey, making sure we are at a place where the flow rates and river width are accurate. Alternatively, we can use whatever width and flow we observe. Have we made an improvement? Probably not. And for a good reason.

The rowboat problem does not expose a working example because real people simply do not do this particular optimization. The visitor would almost surely get in a car and drive to the nearest bridge in order to cross the river. But if that is the central objection to the rowboat problem, then we are obligated to apply the same standard to the corn problem. Who in the corn business does this curve fitting? The student is not told. Why would anyone do this curve fitting? The student is not told. What do the parameters in the fitting function signify in the context of the data? The student is not told. I am suggesting, therefore, that in spite of its use of slightly more realistic data, the corn problem is no better than the rowboat problem, at least for my intended purpose. If one is faulty, so is the other.

On-the-job mathematics enforces a rigorous theme. The owner of the problem has to take responsibility for understanding why the mathematics was done in the first place. The owner is forewarned: An action will be taken as a consequence of the mathematics. Further more, the more sophisticated, and more successful, employees have some grasp of the argument by which the mathematics was invoked. Understanding of the argument permits one to consider alternative methods or, perhaps, to determine whether non-conforming data can be managed with the mathematical procedures at hand.

What is the particular value to a GE student of a course that entails the study of mathematics in the workplace? Only this: Suppose that the student has actually had the experience of doing a piece of mathematics whose conclusion informed the student about a particular decision in an endeavor external to mathematics. I want this hypothesis to be taken literally. No rowboats used by fictitious personnel, no data analyzed without explaining who needed that analysis and why. It is my belief that such an experience could actually convince GE students that they are capable of examining problems of a quantitative nature that they might encounter in business.

In part, this conclusion arises from my intuition, or perhaps, personal taste. However, on at least two occasions at meetings dealing with quantitative literacy, I have asked interested business people in attendance precisely what mathematical tools they wanted their potential non-technical hirees to have. How would they describe the mathematical background that a successful job applicant would possess? In each case, the answer was, "I don't know."

I believe, therefore, that what is needed by potential employers is primarily some confidence on the part of their employees that they can successfully attack on-the-job quantitative problems. It is traditional in mathematics training that we (the mathematicians) will show them the mathematical techniques, perhaps demonstrating those with fragments of real problems. It is not our task, and we don't want it to be our task, to expose students to the actuality of on-the-job problems. Those problems are very messy, and besides, the instructor would have to learn something outside of mathematics in order to find out why they are important. But, I would like to suggest that confidence in solving on-the-job problems comes from solving on-the-job problems.

Now, one must ask, which job? Ideally, we could predict that the GE student is going into food service, or insurance, or web-page design or dress design. This kind of prediction is, unfortunately, impossible. Nevertheless, it seems to me that it doesn't really matter what the job is. Rather, the important thing is that students recognize that correct mathematics coupled with a correct 'model' for the problem at hand is necessary to save money and, in some instances, to stay out of danger. Equally important, as I have suggested earlier, is that students recognize that they themselves can find their way through a muddle of data and solve these sorts of problems. It is inevitable that work of this kind will draw on a variety of different mathematical techniques.

In a particular GE course at William and Mary [4, 5], students use some elementary algebra, some elementary geometry, some elementary trigonometry pretty much on a just-in-time basis. There is no 'chapter' on quadratic equations, no chapter on the law of sines. But there is extensive discussion of the meaning and usefulness of the problem exercises that the students do. And there is always a discussion of why the mathematics works and what assumptions are needed to make the mathematics work. Many exercises demand that students take an algorithm apart to see what makes it tick.

There should be a number of 'jobs' that can serve as a vehicle for such a course. To this point, the only version at the GE level that I know of is the William and Mary example. I would like to encourage others interested in this prospect to try something of their own along these lines. ■

References

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[5] G. Rublein, *Fear of Flying*, Simon and Schuster Custom Publishers, 1999.