Correcting the Course of Math Education

By Johnny W. Lott

PREVIEW

To achieve mathematical literacy, changes must be made to the traditional math curriculum.

Students should approach problem solving from different perspectives that require their full range of knowledge.

Positive actions to achieve mathematical literacy include cross-discipline study, postsecondary education, and teacher preparation.

Mathematical literacy is more than numeracy; it is an individual's capacity to identify and understand the role that mathematics plays in the world and to make well-founded judgments that use and engage mathematics to meet his or her future needs as a constructive, concerned, and reflective citizen (Programme for International Student Assessment [PISA], 2003). The need for mathematical literacy in adults cannot be achieved without clear and specific efforts in schools. And those efforts demand that educators consider what they have been doing and whether their course needs correction. In that regard, principals have a major role to play.

Consider where mathematics education is today. Kilpatrick (2003) wrote: "The 'basics' as we have long defined them in the United States, are relatively limited and shallow" (p. 13). As evidence of this statement, consider, as Kilpatrick does, the Trends in Mathematics and Science Study (TIMSS) analysis of curriculum and classroom instruction suggesting that "current U.S. instructional programs cover many topics but focus on a relatively narrow band of skills within these topics" (Schmidt, McKnight, & Raizen, 1996; Steigler & Hiebert, 1999). This trend does not bode well for mathematical literacy in general.

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Further evidence of a need for course correction comes from the results of the 2003 PISA, which is sponsored by the Organisation for Economic Co-operation and Development (OECD). PISA (2003) seeks "to measure how well young adults, at age 15 and therefore approaching the end of compulsory schooling, are prepared to meet the challenges of today's knowledge societies" (p. 9). Because of its broad goal, the PISA covers mathematics, reading, science, and problem solving and also considers student knowledge and experience and the application of these subjects to real-world issues: "the emphasis is on the mastery of processes, the understanding of concepts, and the ability to function in various situations within each domain" (PISA, p. 11).

Specific content for the PISA is clumped into the categories of quantity, space and shape, change and relationships, and uncertainty. Among the results reported from the 2003 data are the observations that the United States performs less well than might be expected on the basis of its wealth and that the level of student understanding varies from one topic to the other with the United States generally doing better in the area of uncertainty than other areas.

The *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 2000) includes process standards for problem solving, reasoning and proof, communication, connections, and representations. Unfortunately, these process standards are covered only in limited places in the school curriculum although every student needs them to become a mathematically literate adult as defined by PISA. Well-known and highly popular traditional mathematics textbook series pay only lip service to these areas. And traditional standardized tests do not test for these standards in any real way. In addition, other than indicating that the process standards are woven throughout the curriculum, states do not have a consensus on whether or how these process standards should be treated (Lott & Nishimura, 2004).

A Question of Perspective

How can principals, teachers, and curriculum coordinators guarantee that the process standards and mathematical literacy are primary goals in a given school or system? One approach suggested by Packer (2003) asks students (and adults) to assume the roles of workers, consumers, citizens, and individuals to approach problems. From each perspective, students can reach different mathematical answers to the same problem if they are learning the skills and process standards well enough to assume each role and to answer problems in this way. According to Packer, this economist's approach would produce more mathematically literate adults if adhered to.

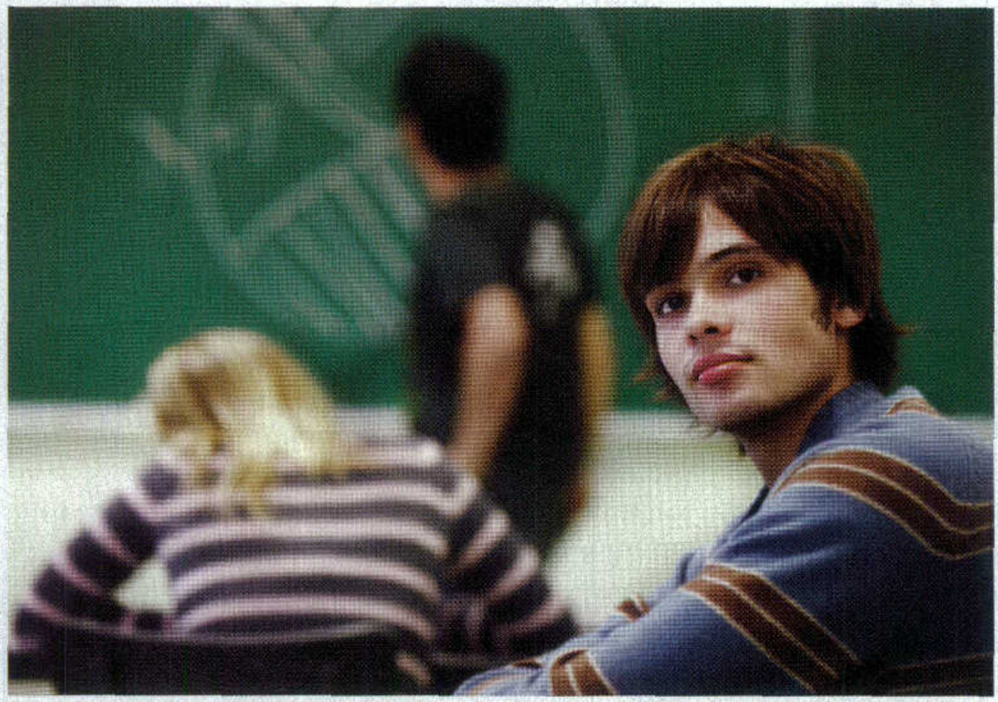
For example, think about how students might answer the following problem:

> Respond to the following statement:
> At the current rates of revenue and payout, the Social Security fund will be bankrupt by the time you retire.

Given the wide-ranging opinions found in the media, every student should realize that people have very different perspectives on the issue of Social Security. There is no automatic response to this problem, but different content-area teachers can work together to have students respond in an interdisciplinary mode. Further, the assumptions that students make when they respond to the statement are important because different assumptions likely will lead to different answers, just as different roles lead to different answers. Because this problem is from the real world, it has implications for mathematics as well as other disciplines. Students may use reasoning, problem solving, or "proof" when reacting to this statement.

Because responding to this statement requires knowledge of history, political science, sociology, and many other disciplines, it may be more appropriate for secondary school students. How students respond will depend on their level of knowledge and the perspective that they take, so this is a good project for students to work on in groups. Whatever that perspective is, this problem can be approached using aspects of mathematical literacy. A starting point for all groups might be a FAQs Web page from Social Security Administration (www.ssa.gov/qa.htm).

If a group answers this question from a worker's perspective, it should be able to determine what percentage of a worker's salary goes into Social Security, how many workers there are in the United States, how much they pay to Social Security, the average of retirement of workers, the expected death rate of people collecting Social Security, and so forth. The group may want to use the calculators at www.ssa.gov for



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FROM EACH PERSPECTIVE, STUDENTS CAN REACH DIFFERENT MATHEMATICAL ANSWERS TO THE SAME PROBLEM.

help. The group should understand how the calculators work and what formulas might be involved in their use. An understanding of how those formulas were developed could be very helpful in framing answers.

A group that has adopted the consumer's perspective might consider looking at the benefits of collecting Social Security and how well those benefits relate to the cost of living to determine whether or not raises in Social Security benefits are needed even if it means bankrupting the system. This group might also consider looking at the benefits that very different consumers receive: a primary worker who collects benefits or the spouse of a primary worker who might not have ever worked in a formal occupation. This group might consider not only the mathematics of cost of living versus benefits but also the social issues of the value of benefits the surviving nonworking spouse of a primary worker receives. Of special interest might be a comparison of the 2006 trustees' report (www.ssa.gov/OACT/TR/TR06/index.html) to the 2005 trustees' report (www.ssa.gov/OACT/TR/TR05/index.html).

A third group could concern itself with the bigger picture of the federal debt and the expectations of the government's future income. It might reach very different conclusions than the group that is worried only about personal benefits. This group may also need to consider the national income, the "average" amount of taxes paid, the percentage of government taxes used to pay Social Security benefits, and projections of each for the future. Although this group might use exactly the same Web sites as the other groups, the trustees' reports for 2005 and 2006 might be particularly useful, and information about taxes and benefits is posted on such sites as http://en.wikipedia.org/wiki/Taxation_in_the_United_States. (Exploring different Web sites could lead to a good discussion about the trustworthiness of information on the Internet.)

Finally, a group could look at Social Security from the student's perspective. How might a student be personally affected if something happened to one or both of his or her parents and how much money might the student receive? The perspective of a student may be different from the perspective of either the primary worker or the spouse of a primary worker. A child of a deceased primary worker may respond very differently to the original statement, even using the same information from the same Web sites.

Teaching Complex Math

Some preparation is required before using such an open-ended statement as a driving force in classroom instruction. Even

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before students are asked to respond to the statement, the principal, the teachers, and the curriculum coordinator might consider the following questions: How do the mathematics curriculum, teaching methods, and other disciplines contribute to help students explain how this statement could be both true and false? Are students ready to speak mathematically and reason on the basis of the definitions and assumptions used?

Although the example involving Social Security is extreme and solving it is beyond the skill of most adults and politicians, that has not stopped them from addressing it. This is the type of problem that adults encounter in the media and on election day. The basic question for principals and mathematics teachers is, Are you preparing your students to approach such problems in an intellectually honest way? *Intellectual honesty* means that students can argue an issue using logical reasoning, mathematics, and connections among disciplines to show that they understand other sides of the issue, regardless of the side they personally believe. If a school is not preparing students to approach complex problems with intellectual honesty, the principal and mathematics teachers must determine whether the curriculum should be tweaked and whether action should be taken to change the program.

Actions and Rationale

"The evidence suggests that the long-running experiment we have been conducting with traditional methods has serious deficiencies and that we should attend carefully to the research findings that are accumulating regarding alternative programs" (Kilpatrick, 2003, p. 13). Explanations of why Kilpatrick makes this statement are available in *A Research Companion to* Principles and Standards for School Mathematics (Kirkpatrick, Martin, & Schifter, 2003). Educators who believe this set of research must take action, including examining the "accumulating research" on alternative programs, making decisions on the basis of the research, and being willing to uphold the decisions that they make.

If principals determine that changes should be made, they must be ready to respond to such comments as "all students can learn mathematics," "many standardized tests do not measure what is valued for mathematical literacy," and "my kid deserves more mathematics than you are teaching; they deserve what I had." The first statement may be made by counselors and mathematics teachers. The second may relate to state testing. And the third may come from parents. These are not simple statements, and the philosophies behind the statements needs to be addressed. If a new curriculum is chosen, principals must be ready to talk about the philosophy behind that curriculum and how it addresses the concerns that these groups may have.

Cross-discipline mathematics literacy. Reasoning, communication, and connections are necessary for mathematical literacy, and no class should be taught without these in mind. Many schools seek to improve students' literacy skills by emphasizing reading and writing across the curriculum; the same can be done for mathematics. For example, English teachers can draw parallels between writing a simple paragraph and developing a mathematics proof. Each needs a thesis statement (or theorem). Each needs supporting statements and a conclusion. The process is essentially the same: similar reasoning is used to reach a valid conclusion. If teachers are not mathematically literate, it behooves their principal to help them become so, which may require dedicating inservice days and hours to building mathematics literacy across the curriculum.

Postsecondary education. Principals should consider meeting with university mathematics departments and mathematics education faculties to discuss the issues of curriculum change. There are several reasons for this. First, any change will bring reaction from some quarters. Adopting an alternative mathematics curriculum at the secondary school level may bring strong reactions from colleges and universities that have come to expect that incoming freshmen will have received a traditional mathematics education. It may be surprising that some colleges and universities defend traditional curricula and teaching practices even though the numbers of collegiate students in developmental mathematics as first-year college students is staggering. Beginning a discussion here must unfold from what schools are doing now to what they will do in the future. This is not a trivial step. The goal is to get the support of the mathematics community.

Prospective teachers. Principals should ensure that teacher candidates are aware of the need for mathematical literacy. Reading and writing literacy is demanded of teacher candidates; mathematical literacy should be also. In addition, a valid concern during the hiring process is determining each candidate's level of mathematics skill. Teachers in every field should be able to use a spreadsheet to calculate weighted averages and determine grades. It is also reasonable to expect, that teacher preparation programs educate prospective mathematics teachers who can give some reasons why mathematics is important in daily life. If a prospective mathematics teacher has taken a course that relates the mathematics studied in colleges and universities to the mathematics that is taught in secondary schools—as advocated by the Conference Board of the Mathematical Sciences (2001)—it shows evidence that he or she made an honest effort to do that.

A united front. As the instructional leader of a school, the principal is responsible for exemplifying the need for mathematics by posing challenging questions that require mathematics for answers in different classes. And the mathematics challenges need not be "normal." The type of questions asked in activities on the television show *Numb3rs* can serve as a model. These activities were developed through the efforts of NCTM, Texas Instruments, and CBS Paramount. These activities are typically for students in high school, but activities along these lines and at www.figurethis.org were also developed by NCTM for use at the middle level. Similar sites exist for other students. Principals can also:

- Offer mathematical prizes for outstanding work involving any aspect of mathematical literacy.
- Pose your difficult budget questions and ask for student input.
- Ask your teachers to use mathematics in classes. For example, how many different tennis matches could be played with a certain set of rules in physical education? How many votes does it really take to elect a president in a social studies class?
- Involve parents in the quest for mathematical literacy by having them talk to students about how they use mathematics to make decisions.

Adults need mathematics skill to function in society. Improving mathematical literacy in schools will improve the mathematics education in the United States but because the public is largely indifferent to mathematics, it is difficult to change traditional education programs. Thus it is necessary to change the public perception of mathematics, even if it is only through one school at a time. And the only way to make a sustained change is through strong leadership from principals. **PL**

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