In this article, we argue that many adults lack the “numeracy” needed to function in a maximally effective manner in their vocational, civic, and personal lives. We believe schools need to foster skills in quantitative literacy (QL), an inclination and ability to make reasoned decisions using general world knowledge and fundamental mathematics in authentic everyday circumstances. We explain how schools might begin to make inroads in preparing more quantitatively literate students and how this goal coincides with efforts toward greater social justice.

The numeracy movement that England popularized in the early 1980s arrived in the United States as “quantitative literacy” later that decade. Several books by mathematician John Paulos, most notably his landmark volume, *Innumeracy: Mathematical Illiteracy and Its Consequences* (1988), strongly contributed to recent public attention to this topic. Lynn Arthur Steen (1997, 1999, 2001), in particular, heightened the education community’s awareness of Paulos’ general call for concern. Although earlier publications and discussions addressed the need for our citizenry’s greater statistical knowledge and reasoning, including its real-world applications and implications, the concept termed quantitative literacy (QL) as an organized, focused entity that has a strong grounding in—but reaches beyond—the domain of statistics is a late-20th-century phenomenon.

Proponents of quantitative literacy as a school goal argue that current mathematics education does not adequately prepare students for their personal or vocational lives. Instead, conventional mathematics teaching often demands acquisition of memorized ideas and procedures that most people cannot apply flexibly to real-world contexts. Such an education is thus “most applicable for future work in a limited number of technical professions” (Orrill, 2001, p. xviii), thus rendering many individuals relatively unprepared for the demands of everyday life. Quantitative literacy, on the other hand, fosters the types of essential mathematics skills and thinking, as well as other important skills, needed to live a more informed, proactive life.

To illustrate the need for such preparation, Best (2001) relates what he thinks “may be the worst—that is, the most inaccurate—social statistic ever” (p. 2), one that escaped many people. The statistic appeared in a doctoral dissertation proposal statement that read: “Every year since 1950, the number of American children gunned down has doubled” (p. 2). Best explains that had that number been only one in 1950, the number would have increased to 32,768 by 1965, far exceeding the combined total of adult and child homicides (9,960), and it would have been 8.6 billion in 1983, about twice the world population at that time. Even worse, the student had obtained this information from a professional journal in the student’s field of study. The egregious error arose from improper rewording of correct information that the number had doubled from 1950 to 1994. “Most of the time,” Best says, “most people simply accept statistics without question” (p. 4). Best also noted that people repeat fallacious statistics, which compounds the problem.

We argue that developing a quantitatively literate citizenry is not only important for creating a more effectively functioning society but also is a matter of social justice in that it places numeric understanding in the hands of “ordinary” citizens, preparing them to function—for example—as informed voters and consumers. Without quantitative understanding in this Information Age, laypersons may be relatively powerless compared with a small number of individuals with specialized knowledge. In this article, we discuss the meaning of and need for quantitative literacy, its implications for social justice, and sample classroom applications of QL.

**QUANTITATIVE LITERACY DEFINED**

Quantitative literacy is a somewhat elusive concept that seems to be described or defined variously without consensus among its advocates. It is not synonymous with mathematics, which is a structured, abstract
discipline that exists in and of itself. Instead, quantitative literacy appears only in context. Schoenfeld (2001) defines QL as “the predilection and ability to make use of various modes of mathematical thought and knowledge to make sense of situations we encounter as we make our way through the world” (p. 51). Here, we define quantitative literacy as an inclination and ability to make reasoned decisions using general world knowledge and fundamental mathematics in authentic, everyday circumstances.

Although quantitative literacy requires a foundation in abstract thinking, it only operates in real-world applications. Thinking quantitatively about real-world phenomena can increase knowledge of these situations, just as—reciprocally—expanding comprehension of real-world phenomena can deepen mathematics understanding (Manaster, 2001). Because QL is intimately interwoven with social and cultural life, it is naturally interdisciplinary. In relating numeracy to the social sciences, Lake (2002) asserts:

An understanding of the social sciences is derived from the interpretation of data—much of it numerical—from such historical or current sources as records offices, bureaus of statistics, and the like. There is probably not one concept in the social sciences the understanding of which could not be enhanced by numerical data. (p. 5)

As noted, abstraction is not the focus of quantitative literacy. Thus, QL skills tend to expand horizontally through engagement with increasingly diverse life contexts rather than to build vertically (Orrill, 2001). In other words, quantitative literacy involves knowing how to apply essential mathematics skills broadly across varied real-world situations rather than building hierarchical abstract knowledge without regard for meaningful applications (i.e., developing an increasingly flexible and nuanced skill set rather than higher, decontextualized knowledge and skills that may have little real-world utility).

Because discussions of quantitative literacy are relatively new and the topic has received little curricular attention, no collective knowledge/skill set has been mutually established. However, selected competencies arise most frequently among those who engage in the conversation (e.g., Gal, 1997, Quantitative Literacy Design Team, 2001, Rutherford, 1997). At the forefront are facility with numbers (e.g., computational skill and number sense), statistical and probabilistic knowledge and reasoning (including data representation and interpretation in graphic and other forms), reasoning and problem-solving skills, and general and technical communication skills. Other concepts and skills might include a basic command of geometry, measurement, proportional reasoning, algebra, mathematical symbols, modeling/simulation, and technological tools, such as computers and calculators. Quantitative literacy skills, which involve fundamental mathematics and other important “everyday” skills (such as effective communication), as well as certain types of dispositions (e.g., a proactive stance toward the world), are pragmatic and are exercised and developed in real-world situations.

Although many mathematics topics are listed among the quantitative literacy skills discussed here, they do not equate with current mathematics education or indicate proportional weighting in relation to the non-mathematics skills. The essential mathematics skills listed here are—as a group—one component of the composite skills that comprise QL. In quantitative literacy, these skills are contextualized through application to authentic situations in ways that are atypical of school mathematics. Thus, “algebra” listed as a QL skill may mean an ability to detect and use patterns in data for real-world purposes rather than to memorize formulas and plug numbers into equations. Moreover, mathematics skills in quantitative literacy are inextricable from other skills that are either less prominent or nonexistent in mathematics education, namely, communication and technology skills, general knowledge of real-world information across all subject areas, and a particular set of dispositions (e.g., a reasonably skeptical and questioning attitude toward data and an action orientation in relation to data-based decisions).

Quantitative literacy presumes an ability to interpret situations, [to] make sense out of claims made, information disseminated, and solutions proposed by government agencies, experts ... interest groups, and friends. About what? The environment, natural resources, immigration, economic trends, health care, crime, consumer safety, investment in research, and more. (Rutherford, 1997, p. 62)

This all-important set of life skills includes, “assessing claims, detecting fallacies, evaluating risks, weighing evidence” (Steen, 1997, p. xix). Quantitatively literate individuals know what questions to ask, such as how data are collected, analyzed, and used. They ask, for example, how the data were selected and from whom and whether a reported “average” of aggregated data is a mean or a median. Quantitative literacy thus includes certain habits of mind and dispositions, such as an action orientation—to make decisions and then act accordingly. It involves real-world judgments, where human decisions go beyond mere data. For instance, is driving ten miles over the speed limit equally remiss in both a 25-m.p.h. and a 65-m.p.h. zone? Law enforcement personnel consider social context and employ value judgments in making this determination, which influences how strictly they enforce driving speed in different zones and what penalties they assign for exceeding posted speed limits.
QUANTITATIVE LITERACY VERSUS SCHOOL MATHEMATICS

A curricular orientation to quantitative literacy is a far cry from traditional school mathematics, which often involves teacher modeling followed by student practice of computation problems, formula use, and unrealistic word problems with little investigative thinking or peer collaboration and communication. The most recent wave of reform-oriented approaches and programs in mathematics education appeared in U.S. schools during the past two decades, owing in large part to publication of the National Council of Teachers of Mathematics’ (NCTM) Curriculum and Evaluation Standards for School Mathematics (1989) and its follow-up documents, most recently, Principles and Standards for School Mathematics (2000). These important guide documents call for meaning-oriented learning, emphasizing, for example, conceptual knowledge, reasoning, investigation, communication, and hands-on methods. Further, the NCTM recommends use of “real-world” mathematics and subject-area integration.

Despite this crucial leap in mathematics education philosophy and the instructional methods and curricula that have sprung from it, reform mathematics teaching and materials are not the same as that advocated in a quantitative literacy approach. A rallying cry for “real-world” mathematics in reform efforts typically translates to word problems with contexts (“stories”) that involve everyday-life scenarios, such as shopping or planning a party. However, the contexts are hypothetical rather than authentic, even though they are less contrived and dull than that of traditional mathematics. They tend to observe standard word-problem formats and reinforce Boaler’s (1994) charge that “many mathematics problems require students to suspend reality and ignore their common sense in order to get a correct answer” (p. 554). This includes, for example, ignoring sales tax in most shopping problems unless percent is the topic of study. Lave (1993) summarizes this matter as follows:

There is a discourse of word problems—a set of things everyone knows how to say about word problems or that can be expressed in “word-problemese,” issues and questions that come up when people begin to talk about them; and things that are not or cannot be said within this framework…. The problems themselves are stylized representations of hypothetical experiences—not slices of everyday existence. If you ask children to make up problems about everyday math they will not make up problems about their experienced lives, they will invent examples of the genre; they too know what a word problem is. (p. 77)

As an example, an item from the problem-centered reform curriculum, Connected Mathematics Project (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1998), reads: “Many pizza restaurants sell small, medium, and large pizzas—usually measured by the diameter of a circular pie. Of course, the prices are different for the three sizes. Do you think a large pizza is usually the best buy?” (p. 70) A series of problems follow in which students explore in conceptual and reasoning-oriented ways relevant knowledge about diameter, circumference, and area. Contrast this problem with having students analyze demographic information by voter race for a local election or national data for women’s versus men’s salaries for full-time work in various occupations. The latter types of problems typify quantitative literacy, in which authentic data is the ideal context, questions are raised about data credibility and implications, investigation of associated social issues is desirable, relevant real-world variables are considered, and a thrust toward social action may result from studying the problem. However, the artificial nature of classroom-implemented curriculum—as well as other schooling constraints—necessarily creates an intersection between the types of methods and materials that are used by reform and QL advocates. Nevertheless, a difference in orientation is evident. This includes the fact that quantitative literacy is interdisciplinary in that all relevant subject matter is important to pursue in the amount of depth and breadth necessary to engage a problem fully. The mathematics of the situation is not an area of focus for its own sake; rather, it is a tool for greater purposes. Thus, the charge for quantitative literacy falls to teachers of all subject areas.

THE NEED FOR QUANTITATIVE LITERACY

An increasing degree of quantification has characterized social and personal life during the past 200 years (Porter, 1997). Test scores, product ratings, and research results are but a few examples of the vast amount of numeric information available to experts and laypersons alike on a daily basis. Many theorists discuss and express concern about inaccurate and misleading data-related practices, as well as a general lack of quantitative knowledge, skills, and dispositions in everyday life functions (e.g., Best, 2001; Huff, 1954; Rutherford, 1997; Wadsworth, 1997). Being quantitatively literate is particularly important in today’s Information Age, where technological advances have yielded a plethora of data—of widely varying credibility—that is available to the average citizen through, for example, personal computers and Internet access.

Quantitative literacy is closely linked to types of participatory practices in, and general quality of, personal, vocational, and civic life. Knowing and employing sound quantitative practices can enhance individual and collective living in areas such as health, education, finances/economics, politics, and social action. Reading the newspaper, choosing a telephone plan, and analyzing
nutrition labels are examples of everyday activities that draw on QL skills. The numerate individual carefully considers and makes informed decisions in these situations. The Quantitative Literacy Design Team (2001) maintains, “In the twenty-first century, literacy and numeracy will become inseparable qualities of an educated person” (p. 9).

The previous discussions indicate that quantitative literacy exists only in context; thus, QL skills are practiced in many different, specific real-life situations. Because these skills are context-bound, they necessarily change as the wider social, political, economic, environmental, and other scenes evolve and as technological advances influence practices. Quantitative literacy, as an entity that shifts over time, therefore calls for adaptive learners who can think flexibly in order to function successfully in personal, social, and occupational life. Ellis (2001) rightly claims, “Quantitative literacy is important because no one knows what life will be like in the future” (p. 64).

Despite well-reasoned arguments for preparing quantitatively literate individuals, the key bastion of education—formal schooling—has not recognized that need or at least translated it into action (for reasons offered later in this article). Schools generally do not teach the types of knowledge, skills, and dispositions that QL requires, thus shortchanging students in their readiness for real-world demands (e.g., Rutherford, 1997; Usiskin, 2001). Steen (2001) notes, “No one has seriously tried to design a school curriculum that gives priority to quantitative literacy…. This is no doubt due in part to the weight of tradition” (p. 110).

**THE RELATIONSHIP OF QUANTITATIVE LITERACY TO SOCIAL JUSTICE**

Each member of a socially just society is treated with fairness and respect and has an equal opportunity to participate in and shape the culture (Glazier & LeConte, 2004). Social justice includes equal opportunities for jobs and income, civic participation, and information and support related to one’s personal life. Quantitative literacy can address issues of social justice in at least two ways. Quantitatively literate individuals are better prepared to address inequitable societal situations, and they can improve their own life quality. In both cases they acquire and exert greater personal power to forge a better life, in the first case collectively for all people and in the second, individually, for themselves and their families.

As noted earlier, life today involves a rapidly increasing degree of quantification. Access to—and ability to understand—numeric information correlates with power in our democratic society. Orrill (2001) asserts:

> Not only specialists but now everyone can obtain and consider data about the risks of medication, voting patterns in a locality, projections for the federal budget surplus, and an almost endless array of other concerns. Potentially, if put to good use, this unprecedented access to numerical information promises to place more power in the hands of individuals and serve as a stimulus to democratic discourse and civic decision-making…. It follows, however, that if individuals lack the ability to think numerically they cannot participate fully in civic life, thereby bringing into question the very basis of government of, by, and for the people. (p. xvi)

Mathematics knowledge and skills can translate into power in that they can be used to build better lives for those who have been historically disenfranchised from key roles in society. For example, some categories of students are screened out or discouraged from pursuing some postsecondary fields, often those fields that are more prestigious and lucrative, such as mathematics- and computer-oriented careers. The students who are generally affected tend to be those who are already marginalized in greater measure than mainstream members of the culture (Herzig, 2004; Holloway, 2004; Malloy, 2002; Moses & Cobb, 2001; Schoenfeld, 2002). Gutstein's (2006) central premise in his recent book on the relationship of mathematics and social justice is that “students need to be prepared through their mathematics education to investigate and critique injustice, and to challenge, in words and actions, oppressive structures and acts” (p. 4).

Individuals lacking requisite quantitative literacy skills are impacted in at least three areas: economic access, civic participation, and decisions for their personal life. Each is described below, followed by a discussion of the way that educating for quantitative literacy can benefit all students, particularly those in marginalized societal groups.

**Economic Access**

In the United States, many students do not learn the kinds of skills they will need to obtain high-level jobs (Moses & Cobb, 2001; Porter, 1997; Steen, 1999). These skills include a combination of mathematics, problem-solving, and behavioral skills, along with a high comfort level with technology (Carnevale & Desrochers, 2003; Cobb, 1997). Traditional mathematics education has failed to provide these skills to both those who take higher-level courses and those who do not:

> Most Americans seem to have taken too little, too much, or the wrong kind of mathematics. Too many people do not have enough basic mathematical literacy to make a decent living even while many more people take courses in high school such as geometry, algebra, and calculus than ever will actually use the mathematical procedures taught in these courses. (Carnevale & Desrochers, 2003, p. 25)
Thus, students learn skills that are not required in their future lives, and many do not acquire the information and facility with real-life data that are essential for higher-paying jobs (Herzig, 2004; Moses & Cobb, 2001).

**Civic Participation**

Just as job skills demand higher levels of quantitative literacy, including technological skill, participation in the democratic process also requires QL skills. Cobb (1997) says:

More and more, debates about issues of public policy such as managed health care and supply-side tax cuts tend to involve quantitative reasoning. More and more, this tends to put such issues out of the intellectual reach of citizens who have depended on public education. (p. 89)

Our society is increasingly split between experts and lay people in that a few individuals have specialized areas of knowledge and can thus contribute to policy decisions related to their field of expertise, while the majority have little knowledge of these areas and little input into decision-making (Gellert, Jablonka, & Keitel, 2001; Porter, 1997). Lay people may not understand quantitative information, in part due to insufficient skills and in part because they may be shown an incomplete set of relevant data. Further, it may not be evident how the data they do see have been slanted in a particular direction. As a result, “innumerate” individuals may fail to understand critical information or be manipulated by politicians, marketing campaigns, and other persuasive persons and situations. They thus forfeit opportunities to make reasoned decisions. In politics, for example, quantitatively illiterate individuals must resort to casting votes by assessing the character and rhetoric of candidates instead of understanding pertinent policies (Cohen, 2001; Porter, 1997). Carnevale and Desrochers (2003) point out the effects of this situation:

The wall of ignorance between those who are mathematically and scientifically literate and those who are not can threaten democratic cultures. The scientifically and mathematically illiterate are outsiders. . . . Their refuge is a deep distrust of technocratic elites that often leads to passive withdrawal from public life or an aggressive and active opposition to change. . . . Citizens who are resigned to being cogs in some incomprehensible machine are not what the founders of the American republic had in mind, nor does such a society put its best foot forward in the global cultural dialogue. (p. 29)

**Decisions for Personal Life**

Just as quantitative literacy is required for economic access and for participation in civic responsibilities in a democracy, adults have a wide range of quantitative decisions to make for their personal lives. These decisions, which can influence quality of life, involve credit card purchases, mortgages, investments, health care decisions, travel planning, choosing cars and appliances, paying taxes, planning for retirement, and other such personal choices. The availability of data related to each of these decisions offers the potential for making informed choices, because authority is not necessarily restricted to experts (Porter, 1997). At the same time, individuals who do not have the necessary skills to understand the data and to make reasoned decisions are left at the mercy of others to decide for them. These decisions, of course, may or may not be in their best interest.

**QUANTITATIVE LITERACY IN THE CLASSROOM**

In contrast to traditional mathematics education, educating students for quantitative literacy offers the opportunity to create a more socially just society in the sense that individuals have similar preparation for participation. If all students are taught in a way that enables them to understand quantitative information from a wide range of sources, consider this information critically, ask appropriate questions, and make well-reasoned decisions, they will be prepared to participate equally as citizens and consumers (Malloy, 2002). Rather than being alienated by school studies that have no relationship to their lives (Gellert et al., 2001), students need to engage with mathematics that relates to their own and their family’s experiences and lives (Malloy, 2002). Instead of learning rote procedures and skills, they need to develop critical thinking and reflective skills, such as an ability to consider what kind of mathematical or non-mathematical/intuitive methods and solutions fit a particular problem (Gellert et al., 2001). Students also need to see that quantitative literacy is required across many of their life experiences as well as the different disciplines they study in school, particularly mathematics, science, and social studies but also including areas such as athletics and music. Carnevale and Desrochers (2003) describe this “democratization of mathematics [as] making mathematics more accessible and responsive to the needs of all students, citizens, and workers” (p. 29).

The call for implementing quantitative literacy into the curriculum is not a proposal for adding more or higher-level mathematics, and it does not necessarily suggest eliminating or reducing traditional mathematics. It is a call for a different and “more progressive pedagogy” across the entire curriculum (Cuban, 2001, p. 90). Teaching for quantitative literacy requires students to engage in activities in which they apply essential mathematics skills within real-world contexts. The teacher’s role is to craft lessons that engage students in authentic situations requiring them to use mathematical thinking.
as the basis of their argument, to “teach the mathematics where it is not understood, show the students how the mathematics looks in the situation and coach the students in applying the mathematics to the problem” (Hogan, 2000, p. 19).

The instructional ideas that follow engage students in quantitative thinking that differs from typical mathematics lessons. They can be implemented appropriately in mathematics and other subject areas. Jordan and Haines (2003) recommend cross-disciplinary collaboration to plan lessons that require students to identify mathematics in contextualized, novel situations in different content areas. Quantitative literacy skills are exercised across life experiences and subject areas. Therefore, QL should not be taught as separate content within the education system.

Researchers interested in the importance of quantitative literacy believe that it can be implemented at all levels of education. However, projects attempted thus far have been developed mainly for students at the undergraduate level (see Jordan & Haines, 2003). This may be because colleges face fewer constraints than K-12 schools in developing and curricula; even so, colleges lack a clear and consistent vision about quantitative literacy and its implementation (Steen, 2001). Hughes-Hallett (2003) suggests that the mathematical foundation of QL develops in middle school. However, we propose that quantitative literacy can and should begin even earlier in a student’s education. To date, few lessons have been created for implementation at the elementary level, although some examples do exist.

Vasquez (2004) explains how she created a classroom curriculum that centered on her children’s cultural and social questions about everyday life. This curriculum engaged 3- to 5-year-olds in discussions that suit the goals of quantitative literacy well. Although the focus of her work was not teaching mathematics, Vasquez’s book presents an impressive account of building from students’ interests and concerns to create the curriculum and focus for classroom dialogue. Her young students analyzed text read to them from newspapers, advertisements, and other print media found in their community. They became deeply concerned about how these sources of information were constructed and about the language used in the texts. They determined that these media influenced their socialization and, in fact, often shaped their understanding of “who they can and cannot be in the world” (p. 86).

A sample activity Vasquez’s (2004) students conducted was an analysis of the purpose for toys given to children at fast food restaurants. They determined that the toys were a major selling point for this industry. They discovered that these restaurants capitalize on children’s desire to obtain certain toys and thus offer toys as enticements for children to ask their parents to go to the restaurants. Some students became very concerned about the fact that some children are unable to collect these toys due to limited financial resources. Another concern was that collectors of the toys could belong to certain clubs on the playground, where membership was determined by mere ownership of particular toys; an inability to have access to these toys was a form of marginalization. This toy-analysis scenario, which was driven by student interest, is an example of a quantitative literacy lesson appropriate for students at the primary level. Questions that might be posed for such an activity include: Why do some restaurants offer toys with the purchase of a child’s meal? If the toys are free, who pays for them? Who benefits from providing these toys to children? Why do restaurants use different toys for these promotions, and how do they choose these toys? Who can and cannot be a collector, and why? These questions require teachers to engage their students in discussions that demand high levels of real-world reasoning and problem-solving skill, as well as use of number sense. Students might decide to take social action and write a class letter of complaint to selected restaurants who use these tactics. The economic awareness and associated personal and social impact that this activity encourages lays the foundation for later, more in-depth analyses that use a variety of advanced skills.

Another QL task appropriate for the elementary grades is to have students determine whether it is more economical to pack or buy their lunch. With appropriate resources, students can be helped to determine the prices of items brought in a packed lunch for a week in order to find the daily cost and compare it to the cost of a school-bought lunch. They can then figure, perhaps with the aid of a calculator, the estimated weekly, monthly, and annual (academic-year) savings of packed or purchased lunches in relation to each other. This type of task can help students see the value of using mathematics to make practical everyday decisions that can affect their life quality.

Mathematics in quantitative literacy lessons should be developed in real-world situations that relate to students’ lives, such as those provided above. At the secondary level, many students are concerned about current and future financial circumstances. The following problem addresses monetary and social issues: What hourly wage would a single parent of two children have to earn in order to live above the poverty line in your state? Factors to consider in this question include housing, food, transportation, child care, health insurance, clothing, and other essentials. Students must collect data on these factors and determine the poverty level for their area. The problem requires students to engage in data collection and analysis, reasoning and problem-solving skills, and numeric computation while considering real-world finances and other relevant variables. Problems of this nature, which might best be done collaboratively or at least in a way that encourages sharing of ideas, allow for
flexibility in how students approach the problem and how they compile different types of evidence to support their decisions. Through classroom discourse, students may ultimately address or be guided to address issues of social inequality.

Other quantitative literacy lessons that can be applied across grade levels involve individuals or groups of students gathering data from several sources and comparing it in order to make an informed decision concerning health options, a particular product, or political positions. Sample topics for this investigation include selecting a credit card that best meets an individual’s needs, choosing a classroom pet, comparing home mortgage loans, buying a used or new car, comparing different viewpoints on a political issue, or choosing a product (e.g., a stereo system or new computer) to buy. The data collection in these activities requires students to make well-reasoned decisions that go beyond looking at numeric information. For example, when choosing a classroom pet, students will need to consider not only how much it costs to care for and feed a particular animal but also whether the classroom is a suitable place to house such an animal. Students might also examine school provisions for various sports teams—and by gender for the same sports—to determine whether they think such funding is equitable beyond mere monetary support. They may include attention to other materials, resources, and services provided, as well as to whether they believe income generated by individual sports teams should impact these teams’ level of school-based financial backing.

Similarly, students might assess school funding for fairness in terms of per-pupil expenditure at schools within and outside of their school system.

Many lessons that require students to think quantitatively can arise out of classroom discussions and critical analysis of articles from newspapers, magazines, or other media. Students should be pressed to consider the validity or quality of the data being presented by asking questions: How were these data collected and from whom? Are the data presented with a particular slant in order to influence readers to think a certain way? How do or can the results of these data impact my life or the lives of others?

The previous examples show how quantitative literacy activities can be implemented in the classroom. They illustrate that learning to be quantitatively literate not only relates to social justice by preparing all students to lead full, empowered lives but also in some cases by serving as a vehicle for exploring issues of social justice directly. Additional examples of such classroom activities may be found at http://unr.edu/homepage/jerryj/NNN/QL.html. These 18 cross-curricular quantitative literacy modules for the middle, secondary, and lower-division undergraduate levels were written at the University of Nevada, Reno in 2002 for the National Numeracy Network. They include such topics as choosing a career, analyzing food labels, exploring home resource use, and analyzing crime statistics. Another good resource for elementary and secondary teaching is the book Rethinking Mathematics: Teaching Social Justice by the Numbers (Gutstein & Peterson, 2005). Radical Math (http://www.radicalmath.org/) is a web site particularly suited to teachers of middle school and higher grades and addresses issues of social justice in the mathematics classroom.

CLOSING COMMENTS

It is hard to imagine that anyone with a humanistic worldview would argue against the need for a more quantitatively literate citizenry. Informed political decision-making, retirement planning, active parenting, and the vast majority of choices we make in our personal, occupational, and civic lives can be better served by improved quantitative understanding and reasoning, as well as accompanying action-oriented dispositions. However, what is not difficult to envision are the barriers faced in suggesting significant changes to the school curriculum. An uphill climb against conventional mathematics, an overcrowded curriculum, and the need for reconstituted teacher preparation is compounded in this case by the logical infusion of quantitative literacy across the curriculum. Steen (2001) says, “Like writing, numeracy must permeate the curriculum. When it does, also like writing, it will enhance students’ understanding of all subjects and their capacity to lead informed lives” (p. 115). This, however, calls for a major overhaul of education, including preparation of all teachers in basic quantitative understanding and its real-world applications. It also means that curriculum content and teacher knowledge must adapt over time to fit the evolving contexts in which quantitative literacy resides. These things, along with lack of clear-cut subject-area divisions in an era of established disciplinary curricular standards, a potentially problematic fit with the present focus on measurable objectives, and possible parental or public resistance to the “less-sanitized” real-world topics explored can be unsettling. To complicate implementation matters further, we have argued that preparation in quantitative literacy should begin in the early years and continue throughout all levels of schooling. Limited initiatives thus far have included the elementary grades in quantitative literacy efforts, so little assistance is available (and it may, in fact, be more challenging to develop appropriate activities and materials for these grade levels).

Despite these obstacles, we must supersede tradition and convenience to help students acquire what they need to be happy, healthy, productive members of society in the present and future. That is not what our education system presently provides. Gal (1997) notes that school mathematics has paid insufficient attention to the goals
and views of the outside world, “which emphasizes what people (rather than mathematicians) need to be able to do and how people actually function beyond the school walls” (p. 39). He further points out that “the goal of preparing all students to cope effectively with numeracy situations as adults . . . can equally serve college-bound and non-college-bound students” (p. 42). This goal implies revisiting current mathematics education in addition to infusing QL across the curriculum. Colleges, as well as government, businesses, and other key societal entities, must play an important part in the drive toward quantitative literacy (Hughes-Hallett, 2003). This is because quantitative literacy across the curriculum “cannot be done at the high school level without the involvement of colleges and universities; high schools will not recognize its importance if colleges and universities do not model it” (p. 98).

All students stand to benefit by becoming more quantitatively literate. Realizing this goal would mean that individuals could have more control over the quality of their personal lives and that the specialized expertise of individuals and small groups could not prevail unchallenged on important societal decisions. The Information Age has placed an inordinate amount of data at our fingertips, and it is a responsibility of formal education to help the common citizen know what to do with it. In this data-driven world, a growing gap between experts and laypersons threatens to place the power of quantitative understanding in the hands of a few. Preparation in quantitative literacy is thus a matter of social justice for all, in particular, for those who have long been marginalized from our school systems and the wider society. Not only does quantitative literacy serve as a useful tool for individual lives; it is a vital part of the mechanism needed for understanding and combating collective social injustices.

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QUANTITATIVE LITERACY FOR SOCIAL JUSTICE

Lynda R. Wiest is an associate professor at the University of Nevada, Reno. Her professional interests include mathematics education, educational equity, and teacher education.

Heidi J. Higgins is an assistant professor at Missouri State University. Her research interests include teaching for understanding, mathematics education, and race, class, and gender in education.

Janet Hart Frost is a doctoral candidate at the University of Nevada, Reno. Her professional interests include mathematics education, educational diversity and equity, and preservice and in-service teacher education.
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