In Focus…

Problem Contexts in the Standards: What is the Message?

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In 1992 Michael Apple critiqued the vision of the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and *Professional Standards for Teaching Mathematics* (NCTM,1991). One of the ideas Apple discussed in his critique was problem contexts, which he found lacking in "socially critical material" (1992, p. 424). He encouraged emphasis on

> examples based on job loss, on the lowering of wages and benefits, on the cutbacks in welfare payments that conservative governments are forcing on already poor parents—each example and problem perhaps centered on how mathematics can help us understand what the effects of all this means for health care (or the lack of it), nutrition, the family's finances, and even on the budget and resources of the very schools the students attend- these kinds of problems would have been powerful ways of linking mathematics to the real world of those students who are least likely to succeed in school. (p. 424)

In 2000 NCTM published the *Principles and Standards for School Mathematics* (Standards 2000) document. Standards 2000 was to be NCTM's "new vision for school mathematics" (p. 3). Having read Apple's critique, I wondered if Standards 2000 contained the socially critical material that Apple had suggested. What message do the problem contexts in Standards 2000 convey?

Categories of Contexts

In order to determine what message Standards 2000 was sending I read and categorized all of the examples presented in Chapter 7: Standards for grades 9 - 12. I selected the Standards for grades 9 - 12 for analysis because they are the most relevant to me as a teacher of first year college students[1]. In addition, It seems likely that if critical issues are going to be presented as problem contexts anywhere in Standards 2000, they would be in the 9 - 12 grade band. Many of the examples presented in the chapter were strictly mathematical. For example, Ms. Rodriguez's class investigation of linear functions (p. 338) is purely mathematical. I did not attempt to count or categorize examples that were absent of context. Some examples were provided in a hypothetical context that was not meant to be other than a cursory backdrop for a mathematical problem, for example Mr. Robinson's class study of his right triangular shaped yard and his faithful dog, Fido (p. 354). In this example Mr. Robinson tells his class that he wants to put Fido on the shortest leash possible that enables the dog to reach all the corners of the yard. The context here was purely cosmetic and hypothetical, hence this example was not included in my analysis. Finally, I did not count as examples those statements that were merely a mention of an application. For example, "the growth of plants is recorded in centimeters per day" (NCTM, 2000, p. 321) was not included since it merely mentions a context in which measurement can be used.

Using a method of constant comparison I developed four categories into which each problem context was classified. As I read through the examples I compared the problem context in the problem under investigation to those I had already read. If the context did not fit into a category I had already formed, I began a new category. Using this method I identified three categories: personal, issues, and work. Personal includes activities that many people do such as listen to a walkman, wear ice skates, eat hot dogs, make phone calls, and go to the movies. This category also includes medical concerns such as flu shots and legal concerns such as parking tickets. The issues category includes broader issues of a social, environmental, political, or economic nature that are relevant to all Americans. A few examples from this category are: amount of living space Americans have, CO_2 concentration, and national spending. A third category, work, involves decisions that are made in various careers. Two examples are an artist's perspective drawing and how a construction worker lays underground pipe. A fourth category, science, was developed for two problems with scientific contexts that did not fit into any of the primary categories described above.

Results of Context Categorization

Of the 37 context based examples in Standards 2000, 19 fit into the personal category, 10 in issues, 6 in work, and 2 in science (see Table 1). This result was a bit surprising to me. My expectation from reading

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chapters 1 and 2 of Standards 2000 was that the context of the majority of the examples would be related to work. The primary message in these introductory chapters is that mathematics can help one achieve his or her economic goals through work:

> In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed. (NCTM, 2000, p. 5)

Additional emphasis is placed on mathematics and how it either allows or constrains one's participation in the scientific and technical community. Though there is some mention of "mathematics... for intelligent citizenship" (NCTM, 2000, p. 4) and as a requirement for "civic participation" (p. 20), the primary message in these early chapters is how knowledge of mathematics can lead to economic independence. This message is not emphasized in the problem contexts of Standards 2000, only 16% (6 out of 37) of which are focused on work related issues.

Fifty-one percent of all the problem contexts were in personal category. A question that critical theorists such as Apple, Stanic and Frankenstein might pose is "whose personal experience?" Are the experiences presented as contexts, such as hot dogs, skateboards, and movies, of concern or interest to most adolescents in America? According to several sources (NASSP, 1996; Strom, Oguinick, & Singer, 1995; and Van Scooter, 1994) the answer is no. Though certainly many students have had experiences with hotdogs, skateboards, and movies, many have not and most are not concerned with such experiences. As reported by Strom, Oguinick, & Singer (1995), the primary concerns of students in the 90's included

> presence of violence, drugs and alcohol in their lives, pressures they experience from peers, hostility toward other racial groups, confusion about sexual involvement and fears of pregnancy and disease, concern about family members, and the difficulty in relying upon adults as sources of support and guidance (p. 355).

These concerns are not addressed in Standards 2000. When reading through the list of contexts one might get at least a partial picture of an idyllic youth preparing to participate in a world of economic prosperity for all. No mention is made of the experiences many of today's teens are involved in and concerned about.

While the picture of personal experience painted by the problem contexts is idyllic the picture painted by the examples in the issues category is a bit more realistic. The contexts in this category illustrate national concerns such as population growth, inflation, gas prices, CO_2 concentration in the atmosphere, and transportation infrastructure. Problems such as these are among those that America faces and that Americans should be involved in helping solve.

Despite the more controversial nature of this category, it does not reflect the major concern of young Americans. The problem teens identified as very

Table 1
Problem Contexts for Standards 2000

Personal
p. 297 Package Weight/ Mail
p. 303 Skateboard Speed
p. 303 Injured Athlete/ Drug in Circulatory System
p. 305 Pricing scheme for Phone Calls
p. 322 Sound intensity/ Vacuuming/ Walkman/ Jet Engines
p. 326 Computer Use
p. 326 Do you wear Ice Skates
p. 326 Tire Comparison
p. 327 Flu Shots/ Getting the flu
p. 327 Test scores
p. 327 Gender/ Favorite Color/ Ethnic Origin
p. 328 Calories in Hot Dogs
p. 328 Movie Screens/ Box office revenue
p. 329 Eye Problems/ Feet Sensitivity
p. 331 Play a musical instrument/sports
p. 332 Alleged parking violation in Sweden
p. 335 Checkerboard
p. 352 Explaining homework on phone
p. 352 Doghouse Design
Issues
p. 219 National Budget
p. 298 Population
p. 305 Inflation
p. 317 Paving Roads
p. 322 Gas Prices
p. 326 Commuter Trains
p. 330 Registered Voters
p. 333 Women promoted
p. 342 Comparison with Japanese students # in family/ distance from school/ unit^2 living space
p. 362 CO_2 Concentration in atmosphere
Work
p. 294 Committees
p. 313 Construction Worker/ Underground Pipe
p. 316 Artist Perspective Drawing
p. 317 Track Lighting
p. 331 Process Control and Quality Control
p. 344 Carpenter's Trick
Science
p. 298 Minutes of Daylight
p. 321 Velocity of an Insect

important in the National Youth Survey (Van Scotter, 1994) and as most important in the NASSP (1996) poll was crime/violence. This issue was not included as a problem context in any of the examples in Standards 2000. Other problems identified by teens as important in America are the decline of moral and social values, AIDS, and drugs (NASSP, 1996). None of these issues were included as problem context in Standards 2000. Even more disturbing than the failure of Standards 2000 to address these issues, is its failure to address the feeling of helplessness that teens feel with regard to how the government might help remedy such problems. More than 79% of those surveyed for the NASSP (1996) poll felt that government corruption and dishonesty is widespread and more than 50% felt that work done by Congress does not benefit U.S. citizens. This view among teens that government is corrupt and ineffectual is certainly not motivational in terms of the continuation of democracy. Problem contexts that address these young citizens' concerns could provide a basis for teaching mathematical content and questioning the status quo.

Discussion

As we can see from the analysis of the example contexts, the "more socially critical material" (1992, p. 424) that Michael Apple noted was absent from the *Curriculum and Evaluation Standards for School Mathematics* is also missing from Standards 2000. In addition, the issues that are addressed seldom intersect with issues that interest and concern many young people. Hence, they may be perceived at best as simply trivial and at worst as irrelevant. The problem contexts of the examples in Standards 2000 should reinforce the rhetoric in the Equity and Curriculum Principles that instructional programs and curriculum should support students' learning, be "responsive to their prior knowledge, intellectual strengths, and personal interests" (NCTM, 2000, p. 13), help students see "the importance and utility of continued mathematical study for their own futures" (p. 13), and prepare them "for solving problems in a variety of school, home, and work settings" (p. 14 - 15). Instead they convey a message that mathematics is only useful for finding solutions to mostly insignificant problems based on experiences of the few. Are problems about the caloric content of hot dogs really personally significant? Do these problems show students that mathematics is important and powerful in their world? If not, students will see the mathematics used in such problems not as important and powerful but rather as simply unconnected to their lives and concerns. In contrast, if students see mathematics set in a political, economic, social, and historical context that is relevant to both their concerns and experiences, they will take an active role in the development of our democracy (Frankenstien, 1987). Mathematics is then seen as part of students' development as questioners of not only mathematics but of societies' uses of mathematics and of the society itself (Apple, 1992).

Comparison with the Curriculum and Evaluation Standards

Though publication of *Curriculum and Evaluation Standards for School Mathematics* (Standards 1989) was a milestone in the development of guidelines for effective teaching, assessment, and curriculum associated with school mathematics, many, including critical theorists (Apple, 1992; Stanic, 1992), mathematicians (Howe, 1998; Ross, 1998; Wu, 1997), and mathematics educators (Kilpatrick, 1997; Romberg, 1992), debated the merits of the document. As Standards 2000 was being developed, attempts were made to get input from individuals and groups both prior to the development of a draft and after a draft was disseminated. These attempts were partially successful in that "more than 650 individuals and more than 70 groups" (NCTM, 2000, p. xi) submitted reactions to the draft. Thus Standards 2000 is a result of the writers, those who critiqued the draft copy, as well as those who critiqued the 1989 Standards. In order to see if the debate that surrounded Standards 1989 had an impact on the types of problem contexts used in the new document, I analyzed the contexts of the examples in the Standards 1989 using the method previously described.

It is worth noting that the four categories developed using Standards 2000 were sufficient and appropriate to classify the contexts of the examples in the Standards 1989. No context based examples were found that did not fit into the existing categories. A comparison of the distribution of the problem contexts among the four categories is presented in Table 2 (See Table 3 for a complete list of results).

Table 2 illustrates the dramatic increase in examples with problem contexts in Standards 2000 over Standards 1989. In addition the majority of the increase is in the personal and issues categories. One can understand the large increase in number of problems in the personal category after reading the following statement in the Chapter 1 of Standards 2000: "The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase" (NCTM, p. 4). What is unclear is why more problems whose context is work are not included. If the message is that "the level of mathematical thinking and problem solving needed for the workplace" (p. 4) has dramatically increased, then why are so few of the examples focused on mathematics used in the workplace?

Table 2
Counts in Categories of Problem Contexts in Standards 1989 and 2000

		Category			
Standards	n	Personal	Issues	Work	Science
1989	18	8	4	5	1
2000	37	19	10	6	2

We can also see in Table 2 an increase in the number of problem contexts in the issues category. However if we look at the percentage distributions, the ten examples with issues contexts in Standards 2000 account for 27%, while this category accounted for 22.2% of the problem contexts in Standards 1989. Not a marked difference. However, the fact that there was an increase in the number of examples that had contexts in the personal and issues category may be an indication that those who were writing Standards 2000 were influenced by the debates about Standards 1989.

Table 3
Problem Contexts for Standards 1989

Personal
p. 144 Best ice cream
p. 151 Auto stopping distance
p. 155 Oven temperature as a function of time
p. 155 Junior class dance
p. 164 Ferris wheel
p. 172 Shooting free throws
p. 174 Cola taste test
p. 177 Compound Interest
Issues
p. 164 Car age/ gas mileage
p. 169 Voting polls/Media
p. 174 Gas consumption for a car
p. 177 Network of one-way streets
Work
p. 141 Assembly line problem
p. 141 Jeans supply in one jeans department
p. 157 Construction - laying a foundation for a garage
p. 158 Art - tiling
p. 164 Surveying - Right triangles
Science
p. 158 Scaling factors for growth

Despite the increase in problem contexts in the personal and issue categories, these contexts are not of the more socially critical nature that Apple (1992) suggested. As I have indicated in my analysis of each category, the majority of the examples are out of sync with current experiences and concerns of today's youth.

So what has been gained by this increased number of examples? Certainly the examples provided in Standards 2000 have more detail and richer descriptions than those in Standards 1989. These examples serve primarily as illustrations of how mathematics can be used to solve contextual problems and how problems can be extended for further investigation (For example: Mr. Hamilton's class p. 342-344). Therefore, though the contexts are not generally of a socially critical nature, they do serve as examples of how contextual problems can be solved using mathematics and may help students see "that mathematics has powerful uses in modeling and predicting real-world phenomena" (NCTM, 2000, p. 16).

Implicit Message

My reading and analysis of the example contexts in Standards 2000 is the basis of the following conjecture: Despite the improvements made in both the number and quality of the examples of Standards 2000 over Standards 1989, the new Standards continue to ignore the power that mathematics can have in debate and discussion of issues critical to the elimination of social and economic inequities in the United States. The basis of this conjecture is the emphasis that the contexts in the Standards 2000 place on what I will call traditional, middle class American issues and experiences. Here I say traditional because in modern America issues such as teen drinking, drug abuse, and teen violence are more typical, whereas the contexts provided in the examples in Standards 2000 are reminiscent of what is perceived by many as a less tumultuous time in America. Though some economic and environmental issues are presented as contexts, the only one that could be considered controversial is the rising CO_2 concentration in the atmosphere. No data on violence, AIDs, or drug use that might be of interest or concern to students are used as problem contexts.

Have we made any progress toward students seeing mathematics as a meaningful tool for social, economic, political, and environmental change? I would answer that we have not. I believe that few students who were not already motivated to learn mathematics for it's own sake will find the contexts provided in the examples in the Standards 2000 document compelling. These problem contexts will certainly not promote questioning of the way mathematics has been used to differentiate among individuals and will fail to encourage students to use these powerful tools to fight for their democracy. The message of Standards 2000 is fairly simple: if you learn mathematics and work hard you can prosper economically and become an informed citizen. The message of the problem context is similar: if you learn mathematics it can help you solve problems that you will experience both at home and at work provided you live in traditional middle class America. I would argue that we as teachers want more for our students than a slogan that supports the current belief that mathematics should be learned for

socioeconomic utility (Apple, 1992). We need both a vision for mathematical content and processes, which Standards 2000 provides, and a vision for how mathematics can be used to question, investigate, describe, and encourage the growth of our democracy, which Standards 2000 does not provide. Should NCTM choose to produce a Standards 2010, I would suggest that the vision included in that document include content, process, and socially critical problem contexts that are of concern to both America as a whole and to its younger citizens. The message of a standards document regarding mathematics education in America should be mathematics for a dynamic democracy.

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[1] Though I restricted my analysis to the Standards for grades 9 - 12, it may be that an analysis of the problem contexts of all the grade bands would produce a different result. Hence I pose the following questions for further investigation: What is the distribution of problem contexts in each grade band (in the whole document) in Standards 2000? How do these compare with those found in Standards 1989?

Conferences…

PME 25. Twenty-fifth Annual Meeting of the International Group for the Psychology of Mathematics Education; July 12-17, 2001 in the Netherlands; http://www.fi.uu.nl/pme25/

An International Conference on New Ideas in Mathematics Education, August 19-24, 2001 in Tropical North Queensland, Australia; http://www.mathed.com/sig/rme/first_announcement.htm

Sixth Annual Conference on Research in Undergraduate Mathematics Education, September 20-23, 2001 in Chicago, Illinois; http://www.math.ilstu.edu/~jfcottr/rume2001.html

PME-NA XXIII, Twenty-third Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education; October 18-21, 2001 in Snowbird, Utah; http://www.pmena.org

ICTCM, 14th International Conference on the use of Technology in Collegiate Mathematics; November 1-4, 2001 in Baltimore, Maryland; http://www.ictcm.org

80th Annual Meeting of NCTM; April 21-24, 2002, Las Vegas, Nevada; http://www.nctm.org/meetings/vegas/index.htm