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What Changes Should Be Made for the Second Edition of the NCTM Standards?

Zalman Usiskin
University of Chicago

UCSMP Director Zalman Usiskin presented this talk at the Eighth Annual UCSMP Secondary Conference, held November 7-8, 1992. This talk has been edited slightly for publication.

Those of you who are unfamiliar with the *Curriculum and Evaluation Standards* or the *Professional Teaching Standards*, and even those of you who are very familiar with these documents, may have thought, when you saw the title of this talk, who cares about the *Standards*? If you have a great deal of freedom at your school to teach what you want to, you might think that the *Standards* are merely rhetoric with little power. But in fact over half of the states in the country have changed their testing programs or curriculum recommendations in light of the *Standards*. Textbook publishers boast that their books agree with the *Standards*, and standardized test publishers are changing the tests because of the *Standards*. And within the past two years the National Science Foundation has funded 13 multi-year curriculum projects—including our own elementary materials component—to help implement what is often called the “vision” of the *Standards*.

Perhaps as significant, dissent from the *Standards* has been meager, primarily because in its journals, books, and conferences NCTM has followed a cheerleading policy that discourages any criticism of the *Standards*. If one is not for the *Standards*, one must be against good mathematics, against good teaching, against good evaluation. Thus you should care about the *Standards* because they affect the materials that will be available for you to teach, the tests your students take, what you hear at conferences you attend, and what you see in the journals you read.

A second thing that you might wonder is, When will the second edition appear? Well, I should tell you that there is no official date for their appearance, because there is no official plan for a second edition. Indeed, one of the reasons for this talk is to encourage discussion of a second edition in the hope that there will be one.

I began thinking about the second edition of the *Standards* when we began thinking about the second edition of the UCSMP secondary books. From 1983 through 1990, we worked on a complete secondary curriculum, and finally, in May of 1991, the last bits of copy for the final pieces of the teacher's edition for the last of the six

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books went to the publisher. It was a Tuesday; I remember feeling so good and so relieved to have it behind me. On Friday, I had lunch with the president of ScottForesman, and—wouldn't you know it—the purpose of the lunch was to discuss how we felt about doing a second edition! Please, I said—we just finished the first one!

You may be thinking the same thing about the NCTM *Standards*. Didn't they just come out? The *Curriculum and Evaluation Standards* appeared in the spring of 1989. The draft of the *Professional Teaching Standards* appeared in 1991. But still it is not too early to think about a second edition, because it takes a couple of years to get a committee together, a couple of years to write, a year to get comments from everyone and get it in final form. So even were the committees to be named now, it might not be until 1997 that the second edition appeared. I myself think the second

edition should appear in 1999 but be announced as soon as possible.

Reasons for a Second Edition

You may also be thinking, we haven't yet implemented much of what is in the first edition of the *Standards* in our district. So why do a second edition? There are a few fundamental reasons. First, the *Standards* will die if there is not a second edition. They will die just as every other report in mathematics education has died. Here is a very brief history of such documents. In 1918 a committee from the Mathematical Association of America and mathematics teacher organizations from New Jersey, Chicago, and a few other areas got together to plan a national report that was ultimately titled *The Reorganization of Mathematics in Secondary Education*. It took five years to do the report, which came out in 1923 and so is known as the '23 Report, and in the interim NCTM was formed by some of these same teacher organizations. The '23 Report was very influential in moving mathematics education away from the view that mathematics should be taught to develop general mental faculties, and towards the view that the practical should be given strong consideration. In this it has much in common with the current *Standards*. The influence of the '23 Report lasted until the effects of the depression caused less attention to be paid to mathematics in schools.

The first major report in which NCTM played a role was a joint report with the MAA in 1940. This report responded to the problems of the depression by promoting a two-track system for high schools, one which would be more academic, with algebra and geometry and so on, and the other a general mathematics track in which the subjects were integrated.

After the war, in 1946, NCTM promoted a set of short reports from a committee called the Post-War Plans Committee. These reports dealt with a set of functional competencies that all students needed to have. If you look at these reports, which were published in *The Mathematics Teacher*, you might be surprised to see some of the same things that reappeared in the 70s as minimal competencies.

Generally, there are national reports only when people see problems. And so it is interesting to note that there was no big NCTM report during the

time of new math, indicating that on the whole, NCTM was happy with the new math. The major report of that era came from the College Entrance Examination Board. NCTM largely abdicated its role as a policy leader during the 60s and 70s, and did not attempt to reassume this role until *An Agenda for Action*, a brief document more political than substantive, appeared in 1980. It called for a curriculum organized around problem solving but also said we still need to determine what problem solving is. Whenever a recommendation is put forward for something that has never been tried, it must be understood to be either political or philosophical. *An Agenda for Action* was not so much a document for something as one against the back-to-basics movement, that is, against the concentration of energy on the teaching of paper-and-pencil skills at the expense of everything else.

As soon as the *Standards* appeared, *An Agenda for Action* was forgotten. There is virtually no history in the *Standards*, no memory of what had been recommended before and failed, what had never previously been recommended, and there is no indication of what if anything is truly new in the *Standards*. Just three weeks ago at the Illinois Council of Teachers of Mathematics meeting, a speaker who ought to know better—a former president of the Illinois council—announced that the history of mathematics education begins in 1989 with the *Standards*. This is a very dangerous

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view. If there is no second edition of the *Standards*, then like all other reports, the *Standards* will be forgotten. They will be viewed as a short-lived fad, and the credibility of NCTM as a player in the arena of mathematics education policy will be diminished if not destroyed. Our major professional voice will have lost power. In the second edition of the *Standards* there need to be some historical perspectives.

As everyone knows, there are people who do not agree with many of the general goals presented in

the *Standards*, people who are waiting for the *Standards* to go away. This is not as farfetched a strategy as you might think. A school district that adopted textbooks in 1990 could easily have said at

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the time that the ideas in the *Standards* were then too new, giving the always-phony excuse, "They are wonderful goals, but we are just not ready at this time." The next adoption for such a district will not likely occur until 1995 or 1996, and the one after that somewhere around the turn of the century. So if things go as they have in the past, if only the district can get past one more major adoption, they can be rather certain that the movement will go away.

We felt we would have the same problem with regard to the UCSMP secondary curriculum: If we did not do a second edition, we would be perceived to have failed. And so I told the president of the publishing company in that Friday lunch that there had to be a second edition of UCSMP, because if there were no second edition people would think that we had failed, despite our influence on the *Standards*, and despite our being used in a huge number of classrooms in the country. We estimate that in the past three years something like 15-20 percent of all purchases of new mathematics textbooks from prealgebra to precalculus have been UCSMP texts, and our primary books are in increasing demand. We have also been quite influential on other textbooks—which was our main goal—but memories in mathematics education are amazingly short.

There is a third reason to have a second edition of the *Standards*. It is because times have changed, even in just a few years. When the *Standards* were written, the first graphing calculator, the Casio fx-7000, had just appeared. There was only one geometry drawing program, the Geometric

Supposer. There was no complete six-year secondary mathematics program like UCSMP's. There was no national goal to be first in mathematics in the world. There was no major movement to change the nature of assessment, not just in mathematics but in all of education. And the middle school movement was not as strong as it is today.

The leaders of NCTM themselves recognize that the times have changed. After I settled on the title for this talk, I heard that there is to be a third volume in the "Standards" series, a volume devoted to Assessment Standards.

A fourth reason to have a second edition is that the *Standards* have been interpreted in various ways by teachers, curriculum developers, teacher trainers, and administrators. The Addenda project of NCTM is an indication that the authors of the *Standards* feel that they have not always been interpreted correctly. And so a second edition can make clarifications.

A fifth reason to have a second edition is that it may just be possible that the *Standards* have some errors, some things that were unwise, and a second look may give the opportunity to correct some of these things. After all, many recommendations in the *Standards* were never tested on a large scale. We have never had a twelve-year curriculum like that in the *Standards*. Would a student actually going through this curriculum meet the goals we desire? To put this in UCSMP perspective, only earlier this year did the first group of students graduate who studied from UCSMP texts in all grades 7 through 12.

A sixth reason to have a second edition is to acknowledge that there are many districts that have already made significant moves that implement or go a long way towards implementing the recommendations of the current *Standards*. Thousands and thousands of school districts have adopted our books or others that cover the wide range of content in the *Standards*, and the wider range of mathematical processes, and some follow if not exceed the technology recommendations in the *Curriculum Standards*. Perhaps thousands of teachers have changed the way they teach their classes along the lines of the *Professional Teaching Standards*. And some of the largest test creators in the country have been revising their tests to fit the *Evaluation Standards*. We should not speak as if

no one has changed, and we should begin to look beyond these changes. Many of the most forward-looking districts are already asking what they should do now. What more needs to be done? Where should they be going? Or perhaps the first-edition *Standards* are so visionary that if you have adopted them, you don't have to examine what you

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are doing any more—you are sitting pretty for the next umpteen years. If so, it would be nice to know that, too. It is as important to know what to keep as it is to know what to change.

And still another reason to have a second edition is the time required for educational reform to have impact. A child entering first grade in the September after the Standards first appeared in the spring of 1989 will not finish high school until the year 2000. We should keep ideas going long enough to see their impact.

Content of the Second Edition

Many of these reasons for a second edition suggest that the second edition should be of the same general form as the first, with the same number of volumes of about the same length. But what should be in those volumes? I will try to indicate what I think should be kept and what should be changed.

Aspects of Mathematics at All Levels

Let me begin with the common threads of the *Curriculum and Evaluation Standards*. The first thing that should be kept are the three aspects of learning mathematics: problem solving—which includes the ability of mathematics to handle a variety of pure and applied problems, communication—which includes all of the aspects of language, and reasoning—which includes both induction and deduction. These are three quite

different aspects of mathematics, and to identify and make them prominent was a brilliant idea.

But a fourth aspect needs to be added: mathematics as procedures. The use and study of algorithms is an important part of mathematics that is not addressed by the first three aspects, and since it is the thing to which most teachers give the most time, it needs to be addressed. Regardless of whether you rely on calculators, computers, paper-and-pencil, or your memory in obtaining an answer to a mathematical question, even in dealing with rich problems in real-world settings, there is still almost always some aspect that is mechanical. Doing the calculations in the Pythagorean Theorem, or finding the root of an equation, or finding percents, or rewriting fractions as decimals is an important part of mathematics.

The current fourth aspect of the *Standards*, mathematical connections, is a theme that has permeated all of my curriculum work. But it is not parallel to the other aspects of mathematics, and it may even be out of place as a standard.

The Grade Levels

The division of standards into K-4, 5-8, and 9-12 was not the result of some discovery that there are huge differences between fourth graders and fifth graders, or between eighth graders and ninth graders. It was simply because thirteen grades are too much to deal with, and three parts seems manageable, and many high schools begin at grade 9. Still, I believe these rather arbitrary divisions should be kept in order to maintain continuity from first to second edition.

However, two years ago this month I gave a talk in Toronto, and I learned that education leaders in the province of Ontario had convened a committee to determine what the standards meant to them. This committee concluded that the K-4 standards were almost entirely devoted to what their schools covered in K-2, and that the 5-8 standards focused primarily on their grades 7-8. This left a big gap in grades 3-6.

It is not surprising that there would be a gap in what is recommended for grades 3-6, because these are the years in which teachers in the past have spent almost all their time on paper-and-pencil computation.

Because the *Standards* do not adequately discuss grades 3-6, students finishing grade 6 in a curriculum aspiring only to the *Standards* do not go as far as they could. And here we have another broad weakness of the *Standards*: although the governmental and business support for change in mathematics education is based in great part on the low performance of U.S. students in international comparisons, the *Standards* simply have not taken some of the best ideas from what is done in other countries. Indeed, the curricula in the countries of the Orient and the former Soviet Union—which had quite a good mathematics curriculum at these levels—have been ignored.

You may wonder why the work in these countries would be ignored. One reason is that the curricula of these countries do not follow the philosophy of the writers of the *Standards*. They do not believe that children always have to construct knowledge for themselves. They do not believe that symbolic mathematics needs to be delayed. They don't believe in Piaget. They don't use calculators.

We may disagree with the philosophies that underlie mathematics in those countries, but we should not ignore them, because as the researchers in the Second International Mathematics Study concluded, we in the United States have had an underachieving curriculum. In particular, we expect less at the elementary school level than almost all other industrialized countries. As a result, students in seventh and eighth grade in almost every industrialized country study what about 75 percent of our students reach only in ninth and tenth grade. Only those students in the U.S. who take a rich course in seventh grade and algebra in eighth grade, our *Transition Mathematics* and *Algebra* or their equivalent, come close to having a curriculum like almost all students in many other countries. For this reason, I believe the standards for grades 5-8 are really more appropriate for grades 5-7.

Curriculum Content in Grades 9-12

The scope of the content of the *Standards* at these levels is wonderful and needs no major changes: every good curriculum should have algebra, geometry, functions, statistics, discrete mathematics, geometry from a synthetic viewpoint, geometry from an algebraic viewpoint, and conceptual foundations of calculus. As you know,

the UCSMP secondary curriculum does, and we are proud of it.

However, it is a weakness of the first edition that what they assign to grades 9-12 cannot be done in four years. We know this because of our experience actually writing such a curriculum. Put most succinctly, the current 9-12 standards need to begin in grade 8. We have had great success in schools that have adopted the entire UCSMP curriculum with algebra offered for the vast majority of students in grade 8.

The Common Core

Although the *Standards* are pessimistic about how early some mathematics can be covered, they are optimistic about who can learn mathematics once it is taught. Individual differences are not considered until grades 9-12, and then they are dealt with by a core curriculum. This is an impossible dream. Children come to school in some communities years ahead of children in other communities, and to assume that they are all the same is a failure to acknowledge their reality. It is not tracking to give

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children the same opportunities at different ages any more than it is tracking to put both 18-year-old and 22-year-old marine recruits through the same boot camp.

A second-edition *Standards* should be more mature and less doctrinaire than the first edition. It should distinguish the ideal we must strive for from the attainable. It should ask that all students be given the same curriculum through algebra and geometry, but not necessarily at the same time. And I must tell you that we have learned in UCSMP that even beginning at different years is not enough. For a

variety of reasons—jobs outside of school, lack of attention to homework, learning style, attitude towards school—some students do not learn at the same pace as others.

Schools that have taught all their seventh-grade students *Transition Mathematics* have one by one come to the conclusion that they must slow down for some students. Some do *Transition Mathematics* and *Algebra* in three years with slower students; that seems a reasonable solution. But if it takes them four years, those students are simply not ready for *TM* and the school should wait.

Role of Exploration

The *Standards* promote what has been called “active learning”, and they pay particular attention to the role of exploration in learning mathematics. Recommended are all sorts of tools to do this exploration, with particular attention to concrete materials. One of the things to happen since the *Standards* appeared is the increasing appearance of more powerful technology to engage in exploration: spreadsheets, geometry drawing programs, and algebra programs that combine graphics with symbol manipulation; graphics calculators that enable graphs to be drawn at will.

With all this ability to generate examples and confirm patterns with examples, I worry about the future of deduction, that aspect of mathematical reasoning that is unique. Induction may generate patterns, but it does not tell us that the patterns hold. Former President Bush knows this better than anyone. His economic advisors kept telling him last year and early this year: Don't worry, recessions last only so long; by the time the election comes around, the economy will have started to pick up, and you will be reelected.

Reasoning using deduction needs to be in the curriculum of all students, from grade 1 up. It is the way we decide whether something is true in mathematics, and to avoid it is akin to teaching science with no experiments. We need to look again at the roles of assumptions, logic, definitions, theorems, and proof in an exploratory environment. It is not enough to say that students will want to confirm the patterns they find: our research indicates that many *PDM* students consider confirmation by example as powerful as confirmation by proof.

Evaluation

I understand that the upcoming assessment standards will review the current evaluation standards. Thus my suggestions may not be for the second edition, but for the first edition of them.

It goes without saying that we should keep the goal of multiple roles and methods of evaluation. I'm not certain that portfolios are the answer, but certainly we should fight the notion that standardized tests or multiple-choice tests suffice. However, there are two changes I would like to see in the evaluation standards.

First, we need some attention to the problems of grading students. I believe strongly that all assessment should be a learning experience, and I believe in the importance of evaluation for diagnosis and remediation, but the fact is that after

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the early elementary grades, there is a bottom line: teachers need to obtain a relatively impartial way of assigning grades to students. The newer assessment rhetoric needs to be fitted into the reality of a very important aspect of the job of many teachers; the requirement that they come up with defensible grades periodically during the year and a final grade at the end.

My second bit of advice is more of a warning: Let us drop this overstated rhetoric about all the old tests being bad. Those tests were used because they are quite effective in fitting a particular mathematical model of performance—a single number that has some value to predict future performance. Until it can be shown that the alternate assessment techniques do a better job at prediction, let us not knock what is there. The mathematics education community has forgotten that it is poor performance on the old tests that rallied the public behind our desire to change. We cannot very well pick up the banner but then say

the tests are no measure of performance. We cannot have it both ways.

Let me be more specific. I believe as strongly as anyone in this room that long division is obsolete. But by the time a child is through with fourth or fifth grade, that child better know how to get the answer in a division situation. By seventh grade or so, that student needs to be able to divide very large or very small numbers. We had better be able

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to show that, with technology allowed, today's students can outperform their counterparts of years ago. I know it seems obvious that this can be done, but I have not seen many studies of this, and some skills, like finding the unknown number in a proportion or rewriting a decimal as a fraction or solving a simple equation, are not necessarily helped by calculators. If it is so easy to demonstrate that using calculators helps, then let's demonstrate it and advertise the huge improvements! Let's let the public know how much better today's students are because they have better technology.

We might use the following rhetoric. When today's algorithms in arithmetic and algebra were invented, mostly about 400-500 years ago, they used new hardware—paper and more recently pencils, and new software—algorithms like partial product multiplication and long division and the quadratic formula. They were the best at the time, but now we have better technology.

Teaching with Technology

Nothing has changed in the past few years more than technology. For this reason, the *Professional Teaching Standards* need to give direct attention to the use of technology in teaching, and by technology I mean here specifically calculators and computers. Guidance is needed regarding the

incorporation of spreadsheets, geometry drawing tools, statistics packages, function graphers, and calculators. It may be time that we begin to recommend that every student have a computer at home, and that we begin to work with social agencies in low-income communities to achieve this goal.

Role of the Teacher

We should not expect as much from the teaching standards as we do from the curriculum standards. Although there is a long history of rather detailed suggestions for curriculum, there does not exist such a long history of recommendations for the teaching process. The *Professional Teaching Standards* venture into generally untrod ground.

The verbs on page 1 of the teaching standards point out the desired role of the teacher: selecting mathematical tasks, providing opportunities, orchestrating classroom discourse, using and helping students use technology, seeking and helping students seek connections, guiding the work of the class. It is a wonderful vision.

But there is something missing. At times direct instruction is needed. To give directions, to set the stage for a new unit, to summarize, to tell a story, to emphasize what is important and what is not, to bring cohesion to the class. All these times and others are suitable for the traditional instruction. There is a reason why direct instruction is so pervasive and so difficult to change; it is because there are ways in which it can be very effective. The importance of the teacher as facilitator should continue to receive emphasis, but the writers of the teaching standards need to take the best from traditional practice as well.

Students

I believe NCTM has placed too much of a burden on teachers. We teachers can change our curriculum, our ways of teaching, and the way we evaluate, but we also need students to change. These changes do not always come automatically even with the greatest teachers. There need to be reasonable expectations about how much students need to work, about the tools we should expect them to have, and about the attitudes they should bring to school. There need to be statements about the roles of homework, and of parents, and of guidance counselors, and of administrators, and of

school boards, and of the other important players in a child's education. But the key has to be the students.

Last year I spoke about this point in great detail, and if you do not have our UCSMP Newsletter No. 10, please write us to ask for a copy.

Finally, I would like to say a few remarks regarding the way we should look at what we do. There are those who wish us to expect our treatments to cure everyone. But why should we expect practices to succeed in education any more than we always expect medical practices to succeed? We should point out to the public that we recommend something not because it is a sure-fire cure, but because on the whole it is the best treatment we know.

It is a sign of maturity to say that there are things we do not know. The *Standards* should not recommend practices that have never been tried on a large scale, as if these practices are certain to succeed. In the second edition, there should be places where options are given—even on important issues. This is easily done in a second edition whose very existence proclaims that it is natural to think of revising the *Standards*. And if the second edition identifies when the third edition will come out, it will not have to think so far into the future. Then when the third edition appears, the work begun by the authors of the *Standards* may be said to have been institutionalized, and we will have a mechanism for an ongoing statement of policy in curriculum, evaluation, and instruction, instead of an isolated document. This would truly be a revolutionary achievement in mathematics education in our country.