

# MathNotations

## Dave Marain Interview with Prof. Lynn Arthur Steen of St. Olaf College

Part I, Sept 12, 2007, Part II, Sept. 14, 2007

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*As reported a few days ago, Prof. Steen, one of the most highly respected voices in mathematics education, graciously accepted an invitation for an online interview at MathNotations. He has been a driving force for the reform of school mathematics for many years and was on the development team that produced NCTM's Curriculum and Evaluation Standards for School Mathematics. For the last few years, he has been involved in Achieve's commitment to developing world-class mathematics standards for K-8 and ADP's similar commitment to secondary mathematics. He will have much to say about these standards and the new Algebra II End-of-Course Exam that will be launched in the spring of 2008. He is a man of great integrity and towering commitment to quality education for all of our children .*

*A few days ago, I emailed Prof. Steen a set of 19 questions that I felt reflected many of the concerns of my readership and, even more, confronted some of the major issues in mathematics education today. He agreed to reply to all of these, asking only that I publish his remarks in full. My role here was purely reportorial. This is not a debate. Once the questions were composed I stepped back and allowed him free rein. Prof. Steen replied thoughtfully and candidly within 48 hours. If you've stopped here by the side of the road, tell your friends and colleagues about it. I invite fellow bloggers to spread the word across the blogosphere as well.*

*The interview includes useful background information about the new Algebra II End-of-Course Exam, its purposes, its content and its impact on districts that use a 3-year integrated math sequence. Prof. Steen also courageously tackles issues as diverse as proficiency with fractions, the role of factoring in the 21st century, AP Calculus as a model for a national curriculum, the linear mastery model of learning mathematics, gifted education, the critical factors needed to elevate mathematics education in our country, and attempting to resolve the Math Wars. He ends with advice for mathematics educators, restating the core message of the NCTM Standards.*

*Philosophically, Prof. Steen and I have much common ground, although we diverge on some key points. What I truly believe is that honest dialog is the only way we can move forward, end the Math Wars and reach a strong middle-ground position that best serves the interests of our children. Whatever your ideology may be, Prof. Steen's comments are profound and thought-provoking. Enjoy!*

*I want to express my gratitude to Prof. Steen for taking the time to reply thoughtfully to some difficult and controversial questions regarding mathematics education. I'm hoping that this forum serves as a springboard for other bloggers to have further conversations with educational leaders and, perhaps, bring opposing parties together at an 'online roundtable. Regardless of personal ideologies, I hope those who have or will visit will find this interview as thought-provoking as I did. One thing is for certain. Both Prof. Steen and I have a new-found appreciation for how difficult it will be to resolve the major problems in education, mathematics education in particular. Again, I invite readers to post comments and keep the discussion alive. [Extensive commentary can be found at the links given above. --LAS]*

— — Dave Marain, September, 2007

### **Math Notations Interview with Lynn Arthur Steen, September, 2007**

1. *Prof. Steen, your involvement in so many mathematics and science education projects is mind-boggling. At this time, what are your greatest concerns regarding mathematics education in the U.S.?*

That in our stampede for higher standards we are trampling on the enthusiasms, aspirations, and potential contributions of many students for whom mathematics is best approached indirectly. agriculture, government, music, and sports, but students don't get to see these until large percentages have already given up on mathematics. It is true that mathematics unlocks doors to future careers. But we also need to open more doors to the world of mathematics.

2. *Over a dozen years ago, Professor Schmidt, Director of the U.S. participation in TIMSS, made his famous comment about our mathematics curriculum being 'an inch deep and a mile wide'. He also stressed the importance of having a coherent vision of mathematics education. Since then, fifty states have independently developed sets of mathematics standards and assessments. Although similar in some respects, they lack overall coherence and consistency of high expectations of our children. What is currently being done nationally as you see it to remedy this situation?*

Notwithstanding our constitutional tradition of federalism that leaves states responsible for education, some now suggest voluntary national standards as a cure for the incoherence and inconsistency that is evident in state standards. Indeed, Senator Dodd (D-CT) and Representative Ehlers (R-MI) have introduced just such a bill in the Congress. I rather doubt that there is sufficient political support for nationalizing education in this way. Nor do I think it would resolve the problem. It would simply shift the locus of inconsistency from written standards and assessments to teachers and students.

More promising are efforts such as the American Diploma Project Network which is an ad hoc coalition of states that decided to work together on a common education agenda. This is not a "national" effort, but it is more in keeping with the traditions of our nation. Public distribution of comparative data is another strategy for reducing unwarranted inconsistency. Recent studies such as Mapping 2005 State Proficiency Standards Onto the NAEP Scales (NCES, June 2007) that compare states to the common scale established by the National Assessment of Educational Progress lead naturally to improvement motivated by competition or, in some cases, by embarrassment.

Strategies that open more doors to mathematics are more likely to emerge in smaller jurisdictions, for the simple reason that innovation begins locally and the doors that need opening tend to have local roots. So I'm not terribly bothered by lack of coherence and consistency. I'd rather focus first on getting more students to learn more mathematics of whatever kind may interest them. What counts is that students gain sufficient experience with substantive mathematics—not just worksheets—to benefit from its power and, if possible, to appreciate its beauty.

3. *What were some of the obstacles faced by Achieve's Mathematics Advisory Panel, both at the K-8 level and for the secondary curriculum? Were many of the current conflicts in mathematics education (aka, the Math Wars) overcome by this Panel? If not, what issues remain?*

This is not a simple question! First, Achieve's formal Mathematics Advisory Panel (MAP) was constituted to work only on the K-8 level and produced *Foundations for Success*, a report with outcome expectations and sample problems for the end of grade 8. When work moved into the secondary level, it became part of the American Diploma Project (ADP) and operated with an evolving set of advisors representing all levels of mathematics and mathematics education.

From the perspective of the "math wars," the original MAP panel was, for its time, a remarkably catholic forum. Strong voices from many different perspectives set forth conflicting views. Compromises were agreed to, and sometimes reversed after further discussion. Eventually a report emerged. No one was pleased with every detail, but I believe it is fair to say that everyone on the MAP committee agreed that as a whole it represented a good step forward.

We reached this point by agreeing to set aside issues of pedagogy and to concentrate only on content. We further agreed that lists of expectations were less capable of conveying our intent than were rich examples. That is why the final report had 8 pages of expectations and 130 pages of examples. It was far easier for the diverse MAP members—protagonists, witnesses, and victims of the math wars—to agree on the quality of a problem than on the wording of a standard.

We also choose to largely ignore the issue of calculators because it was one of the wedge issues on which we all knew that the panel could never agree. Some may view this as cowardice, and it may be that. However, it made possible the rest of the work and affirmed, in a sense, that issues such as this may best be left for local decisions.

Another wedge issue we faced head-on, namely the place of quadratic functions and quadratic equations. Here we compromised, setting an ambitious bar for end of eighth grade at completing the square with a deliberate mandate to not employ the quadratic formula until the next algebra course. The purpose, of course, was understanding rather than calculation, a goal that in this case everyone around the table could support.

Those on the panel with the most school experience worried that completing the square was much too ambitious. They were proved right in subsequent reviews from states who wanted to use the *Foundations for Success* as a guide for their own standards. Consequently, later Achieve documents dealing with the transition from elementary to secondary mathematics are much more realistic about just how much algebra can be expected for all students prior to ninth grade.

Secondary mathematics is part of Achieve's ADP effort; the benchmarks together with sample postsecondary tasks appear in *Ready or Not: Creating a High School Diploma That Counts* (Achieve, 2004). There the contentious issue concerned the quantity of mathematics, especially of algebra, that should be required of all students for a high school diploma. A compromise was reached in which certain benchmarks, marked with an asterisk, were described as recommended for all but only required for those "who plan to take calculus in college." Of course, this asterisk mildly undermines the nominal goal of the ADP enterprise, namely, to set a uniform standard for an American high school diploma.

These matters—the role of calculators, the amount of algebra—are but two of the issues that remain fundamentally unresolved both within the ADP networks and among individuals who care about school mathematics. Other sources of continuing disagreement concern the role of data analysis and statistics, the place of financial mathematics, the importance of arithmetic "automaticity" and a host of pedagogical issues that, as I noted, Achieve largely leaves to others.

*4. I've expressed great concern on this blog about the lack of frontline teacher representation on these major panels, particularly the President's National Mathematics Panel? I've reiterated my call for redressing this situation via numerous emails to the Panel and on this blog. To date, all such requests have been politely dismissed. How do you feel about the need for increased teacher representation on this and other panels? Was there more K-12 representation (current classroom educators) on the Mathematics Advisory Panel on which you served?*

The names of all those who advised Achieve on its MAP and ADP projects are listed in the reports of these projects. Different individuals contribute different types of work: some meet in panels; some review drafts; some write standards or contribute problems. My impression is that quite a few of Achieve's mathematics advisors have taught K-12 mathematics, but relatively few were serving as "frontline teachers" at the same time as they were helping with the Achieve work. Frontline teaching doesn't leave that much spare time.

Generally, I find concerns about representation less important than those about relevant experience. Sometimes the complaint is about the lack of teachers, other times about the lack of mathematicians; often complaints are accompanied by qualifiers (e.g., "current classroom teachers," or "active research mathematicians") that appear to imply that those who do not meet the condition are somehow less capable. What matters is that a panel as a whole include individuals with a broad balance of experience, which for mathematics education certainly includes both mathematical practice and classroom teaching—but not necessarily all at the same time the panel is meeting.

*5. Many critics of NCTM's original 1989 Curriculum and Evaluation Standards for School Mathematics and the revision in 2000 have claimed there was not enough emphasis on the learning of basic arithmetic facts. In your opinion, is the issue primarily due to lack of clarity in the standards, or is there a real difference of position between NCTM and its critics on the importance of arithmetic facts?? What is your position on the relative importance of the automaticity of basic facts?*

There is a range of opinion about the importance of arithmetic facts within NCTM, within the broader mathematical community, and within the public at large. I understood the 1989 *Standards* to acknowledge this fact. A chief insight of statistics is recognizing the importance of variation. Student and adult skills with arithmetic vary, so the goals of mathematics education must take this into account. Almost all disputes about NCTM's standards arose because the historic absolutes of mathematics were replaced by alternatives and variations. In this sense, the critics were right: the Standards made mathematics "fuzzy" by insisting that most problems can be solved in more than one way. In fact, they can be.

There is no dispute that knowing arithmetic facts is more desirable than not knowing them, and being quick ("automatic") is better than being slow. The issue is: how important is this difference in relation to other goals of education? It is a bit like spelling: being good at spelling is more desirable than its opposite, but there are plenty of high-performing adults—including college professors, deans, and presidents—who are bad spellers. They learn to cope, as do adults who don't instantly know whether  $7 \times 8$  is larger or smaller than  $6 \times 9$ .

For what it's worth, my "position" is that every child should be taught to memorize single digit arithmetic facts because if they do so everything that follows in school will be so much easier. But

failure to accomplish this goal should not be interpreted as a sign of mathematical incapacity. Indeed, both students who achieve this goal and those who do not should continue to be stimulated with equal vigor by other mathematical topics (e.g., fractions, decimals, geometry, measurement), just like both good and bad spellers continue to read the same literature and write the same assignments.

*6. Many secondary teachers decry the lack of proficiency with fraction skills and fraction concepts demonstrated by their students. It's always easy for each group of teachers from graduate school on down to place blame on prior grades. Do you believe that Achieve has addressed this problem adequately with their enumeration of K-8 mathematics expectations in their 2002 publication, *Foundations for Success*?*

The expectations summarized in *Foundations for Success* certainly subsume the arithmetic of fractions and the relationships among fractions, decimals, proportions, and percents, but they do so quite concisely. Details are unfolded in Achieve's *K-8 Number Benchmarks*, especially throughout grades 4-6. However, no one associated with this project was so naïve as to imagine that the mere inclusion of an extensive discussion of fractions in a report will adequately address the problem of students entering high school—or college, for that matter—without understanding fractions. Setting out clear expectations is only a first step.

*7. What is your position on the role of technology, calculators in particular, in K-4, 5-8 and 9-12 mathematics classrooms?*

My view is that students should learn to use technology wisely, carefully, and powerfully. By wisely, I mean that they make conscious and appropriate decisions about when to use calculators or computers, and when not to. By carefully, I mean that they think enough about the problem they are working on to recognize when a calculator or computer result is beyond the realm of plausibility. By powerfully, I mean that they make full use of the most powerful tools available in order to prepare rich and accurate analyses. In this age, mathematical competence requires competence to use computer tools, so the use of technology must be an explicit goal of mathematics education.

It no more follows from students' widespread misuse of calculators that calculators should be banned than from students' widespread misunderstanding of fractions that fractions should be avoided. Use of technology is as important as use of fractions, and both need to be taught and tested.

*8. I have stated repeatedly on this blog that the Advanced Placement Calculus syllabus from which I taught for over 30 years, is essentially a national curriculum for calculus and that I strongly endorse it as such. Do you agree with this characterization? Do you see projects such as ADP moving in a similar direction, working closely with states to achieve a common set of mathematics topics K-12 that must be covered at each grade level?*

As AP courses go, AP calculus is one of the best. By intent of its sponsor (the College Board), it follows rather than leads national trends. For example, the most recent revision took place a few years after (not before) implementation of pilot projects supported by NSF's calculus reform program. The momentum for change was led by college faculty, not by the College Board. ADP has a more ambitious goal, namely to lead the nation's K-12 schools to higher standards. In contrast to AP calculus whose syllabus is in the mainstream of college calculus courses, the

expectations produced by MAP and ADP are on (and sometimes beyond) the leading edge of K-12 mathematics programs.

*9. The types of problems Singaporean children, for example, are tackling seem more complex than their grade counterparts in the U.S. Do you believe that most mathematics curricula in the US, particularly in the area of problem-solving, are as challenging as those in other high-performing nations?*

U.S. education clearly lags behind many other nations. This is not just a matter of curriculum but of teacher preparation, time in school, parental expectations, community environment, and perhaps funding. Some other nations (e.g., Japan) decided that their curricular expectations were too high and have reduced them. Others (e.g., England) have seen student performance fall. As I implied in my answer to the previous question, the MAP and ADP expectations, being calibrated to international standards, are well beyond what can be achieved at this time by most districts for most students. Their purpose is to set a target, but to reach that target we will need to change much more than curriculum.

*10. The End-of-Course Algebra II exam will have a central core and 7 optional modules. Why were traditional topics such as log functions, matrices, conics and sequences/series pulled out of the core? Also, were the standards influenced by the Algebra II topics currently included on the SATs?*

The traditional Algebra II course was developed as a stepping stone to calculus for the minority of students who felt they might want to study further mathematics. Two decades ago fewer than half of the age cohort took Algebra II. Today's course is intended for all students; it is a requirement for high school graduation in more than half the states. So it is natural that the "core" of Algebra II be rethought, with more specialized topics set aside into optional units. The new Algebra II may well be the last mathematics course ever taken by many of today's high school students, so I hope that the topics included in the new syllabus and test are well suited to the needs of all students.

I say "hope" because I actually know very little about the details of the test development process. In particular, I do not know if anyone has made any effort to coordinate topics with the revised SAT.

*11. I'm assuming that school districts are already or soon will be receiving more detailed information concerning the new End-of-Course Algebra II exam. Will there be a full sample practice test made available? The Achieve web site will be helpful to Algebra II teachers, but could you suggest some additional resources they could use?*

I am even more ignorant of these implementation issues than I am about the course goals. While it is helpful to see sample tests, the best way to prepare for an Algebra II test is to study a wide variety interesting and challenging problems. The internet is full of sites that offer enrichment and challenge problems for different high school courses. I'd suggest exploring the Math Forum in the United States and the Millennium Mathematics Project in the United Kingdom.

*12. In your opinion, how will the End-of-Course Algebra II exam impact on those districts that use a 3-year integrated math sequence?*

This is a very important question, and relates directly to the issue you raised earlier about what constitutes the core of the course. In my view, since passing the new end-of-course Algebra II exam will be a requirement for high school graduation for many students, it should be thought of more as an exam covering the third year of high school mathematics than as an exam covering algebra topics that are needed for calculus. Clearly there is much overlap in these two perspectives, but there are also some differences. I understand that the strategy of a core test with optional modules is intended precisely to reflect these two options. I remain concerned that the older calculus-focused view remains too dominant, at the expense of many newly-important topics that serve to introduce combinatorics, finance, probability, statistics, computer science, etc.

13. *I still have a hard time when a student reaches for the graphing calculator to analyze the signs of the quadratic function  $f(x) = x^2 - 2x - 8$ . Most textbook publishers have deemphasized factoring, relegating it to the back of the book. Educators have generally followed suit, although not all. How do you view the role of factoring in Algebra II and the secondary curriculum in general?*

Factoring is one of the topics on the borderline of the two perspectives on Algebra II—preparation for life vs. preparation for higher mathematics. For life (e.g., citizenship and personal living) factoring is a relatively useless skill. For higher mathematics, the conceptual role of factors is crucial, but all real problems that may require factors are solved using computer tools (e.g., *Mathematica*). The only place where actual factoring of factorable polynomials is required on a regular basis is in mathematics courses. My advice is to be honest with students about this skill (and others like it). It is important for certain purposes, but not a life skill.

14. *A recent article in Time magazine as well as a recently published book by Alec Klein make a strong case for gifted education and developing the talents of our brightest math and science students. Do you believe that our most talented math students are being adequately served? In particular, do you believe they can they flourish and develop equally well in heterogeneous classes as in fast-track accelerated classes?*

This too is a very important and difficult question. Research and experience confirm that the presence of bright and intellectually aggressive students in a class helps propel all students to higher levels of achievement, so pulling these students out will in most cases make it less likely that the average students will reach their full potential. On the other hand, bright students whose mind has moved beyond the class syllabus—which is very common in mathematics—will be bored, resentful, and rebellious. Neither option is good; each short-changes far too many students.

Taking a clue from game theory, it seems to me that a mixed strategy is the best compromise: some work together, some work separate. In addition to raising the bar for average students, mixed groups help accelerated students learn to communicate mathematics—a skill that every client of secondary education—employers and professors alike—report is in very short supply. Separate groups help teachers and students focus on problems that are calibrated to match students' current skills.

However, even when students are separated by skill level, acceleration is not the only option. Mathematically able students should be challenged as much as possible by opportunities for horizontal exploration of optional topics that are not part of the mainstream curriculum. For many students, excessive acceleration is a great disservice. Except for the tiny minority (beyond three sigma) who need to take college mathematics while still in high school, most student who finish

the school mathematics curriculum early wind up with a gap between high school and college mathematics, with rushed rather than deep mastery of high school topics, and with little or no opportunity to employ the mathematics they learned in parallel natural or social science courses. It is appalling how often students who receive a passing grade on AP calculus discover upon entering college that they need to take remedial algebra since they have forgotten whatever little they learned in their pre-calculus rush. Far better to slow down, spread horizontally, and dig deeper into the hidden corners of the regular curriculum.

*15. Many mathematics educators I've spoken to and worked with believe that the learning of mathematics is essentially linear, i.e., one cannot be successful at level D unless one can demonstrate proficiency with levels A, B and C. What is your view on this model of learning mathematics? In particular, do you believe that students need to demonstrate proficiency in arithmetic skills and numeration before moving on to algebra?*

The linear model of mathematics learning is wrong in almost every respect. Cognitive scientists remind us that the human brain learns by association, not logic. The history of science is full of examples of researchers who came to parts of advanced mathematics via some phenomenon or theory, not by a logical ladder of mathematical steps. Science students frequently encounter and use parts of mathematics in a physics or biology course well before they encounter it systematically in a mathematics course. Fields medalist mathematician William Thurston once described mathematics as like a banyan tree with branches that take root in different places, providing nourishment and growth along multiple pathways (*Notices of AMS* 37(1990) 844–850).

It is also extraordinarily counterproductive to our national goals. Dozens of reports have raised alarms about shortages of mathematically trained graduates from schools and colleges. Curricula and requirements based on the assumption that there is just one proper path to mathematics artificially and unnecessarily restrict potential mathematics graduates to those who find an intellectual kinship with that preferred approach. It cuts out those who might approach mathematics from other directions, be it from biology, or statistics, or computers, or finance, or construction, or energy, or environment, or any of a dozen other things that may interest students more than mathematics but which share a side door to mathematics.

*16. Many states 'talk the talk' about higher standards and expectations, but translating these goals into reality in the classroom has proved difficult. Could you rank order the most important factors that are needed to accomplish these goals? For example, would you place teacher preparation above textbook quality?*

Enthusiastic and imaginative teachers who are both mathematically and pedagogically competent are more important by far than anything else in the educational system. In particular, competent teachers need to be free to teach in whatever way is effective for them—which implies minimum constraints from state- or district-imposed curricula and tests. Imaginative teachers with minimum constraints would produce a lot of innovation; required standards and high stakes tests tend to stifle innovation. Clearly, some common expectations and assessments are important, but they should focus on the broad goals of education, not on narrow particulars.

Why do we get narrow particulars (that is, "standards") instead of imaginative teachers? The answer is obvious: money and political commitment. It is cheaper by several orders of magnitude to convene a consensus process to write standards than to attract, educate, and retain people with

the interests and skills needed to teach mathematics well to all our nation's students. When you don't have enough teachers with the required competence, then the way politicians "make do" is to lay out specific standards and assessments for everyone to follow. I don't think we have much evidence that this strategy will work.

*17. Hindsight is always 20-20, but if you could go back in time to the development of the original NCTM standards, what are some changes you would make, in light of what has transpired over the past two decades?*

It is important to remember that at the time NCTM published its 1989 *Standards*, the very concept of standards was a subversive idea. Even the definition was in dispute: some viewed a standard as a banner to march behind, others as a hurdle that must be cleared. In this context, it was proper for NCTM to be somewhat cautious. Certainly there were places in the Standards where intentions were not adequately communicated, but nothing can ever prevent critics from selective reading. It is only human to read into a text what you want to find. Consequently, different readers read the *Standards* differently.

I read them as clarion call for eliminating the tradition, most evident in mathematics, to select and educate only the most able students and to provide others, disproportionately poor and minority, with only the illusion of education. For the first time a powerful national voice said that all students deserve a mathematics education. How this can be done, and how long it should take, are details that are still being worked out (as your earlier questions about MAP, ADP, and Algebra II attest). This commitment, that every student deserves an equally good education, is the one unequivocally positive aspect of the No Child Left Behind (NCLB) law.

If I were able to go back and make any change, I would highlight that central message more, and make clear that the suggested particulars were to be worked out through traditional American strategies of local innovation. The mistake NCTM made, if it can be called a mistake, was to let its critics define its message as the particulars rather than to keep the nation's attention on the central goal of providing all students with a meaningful mathematics education.

*18. Here's an innocent little question, Prof. Steen! The current conflicts in mathematics education are usually referred to as the Math Wars. In your opinion, what were the major contributing factors in spawning this conflict and how would you resolve it?*

There are many factors involved. I think I can identify a few, but I have no confidence that I could resolve any of them.

One is the natural tendency of parents to want their children to go through the same education that they received—even when, as often is the case with mathematics, they admit that it was a painful and unsuccessful ordeal. This makes many parents critical of any change, most especially if it introduces approaches that they do not understand and which therefore leaves them unable to help their children with homework.

Another source were scientists and mathematicians who pretty much breezed through school mathematics and who were increasingly frustrated with graduates (often their own children) who did not seem to know what these scientists knew (or thought they knew) when they had graduated from high school. Our weak performance on international tests appeared to provide objective confirmation of these concerns, and they came to public notice just as the NCTM *Standards*

became widely known in the early to mid-1990s. Even though very few students had gone through an education influenced by these standards, the confluence of events led many to believe that the standards contributed to the decline.

A third source can be traced to the way in which the NCTM *Standards* upset the caste system in mathematics education. Mathematicians are accustomed to a hierarchy of status and influence with internationally recognized researchers at the top, ordinary college teachers in the middle, below them high school teachers, and at the very bottom teachers in elementary grades. The gradient is determined by level of mathematics education and research. So it came as somewhat of a shock to research mathematicians when the organization representing elementary and secondary school teachers, seemingly without notice or permission, deigned to issue "standards" for mathematics. Mathematicians would say, and did say, "we define mathematics, not you."

I could go on, but won't. But I do want to add that, as with any contentious issue, face-to-face dialog helps bridge differences. With some exceptions, I believe that has happened with protagonists of the math wars. Achieve was one of the first organizations to bring to one table people from all these different perspectives. Subsequently, other groups have made similar efforts, generally with good results. As mathematicians and educators roll up their sleeves to work together on common projects, each learns from the other and the frictions that led to the math wars begin to reduce.

*19. Finally, I've observed considerable frustration among K-12 mathematics educators for the past 20 years. Each wants to do what she/he perceives is the best for her/his students but they are often mandated to follow new curricula and programs that come and go every few years and for which they often receive inadequate training. What message would you like to convey to these dedicated professionals?*

I said above that teachers are the key to success in mathematics education, but that outsiders impose standards and assessments as a means of protecting students against soft spots in the system. This is not unreasonable, since in the K-12 sector the state is responsible for guaranteeing that children receive a proper education. It seems to me that the only way that teachers can regain control over their own affairs is for them to convincingly take on the role of ensuring quality education for all children. That will require much higher standards for initial licensure, for tenure, for professional development, and a commitment to post-tenure reviews. This is the regimen followed by most good colleges and with suitable modification, by hospitals. Self-imposed quality control is the sign of a true profession.

The problem teachers face is a severe mismatch between the needs of K-12 education, especially in mathematics and science, and available resources. But here teachers have an asset that they need to make better use of, namely, regular access to parents and school boards. What they need to do with that access is help the public understand the changing nature of mathematics and science, the unique value it offers their children, the challenges involved in keeping up with a rapidly changing discipline while at the same time teaching students of quite varied skills and preparation, and the concrete steps that teachers have taken to ensure that all students receive a sound education. Focusing on quality for all—the core message of the NCTM *Standards*—should gradually elevate the respect in which teachers are held and with it, the support they receive from the public.