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Improving Equity and Education: Why and How

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Synopsis

Progress is possible. When I graduated from college, only 5% of the new U.S. doctorates in mathematics went to women; now it is about 30%. There is of course room (and need) for more progress. This paper begins with an account of my research about women and black mathematicians. The latter group claimed that racial equality can be achieved only when better elementary school mathematics education is available to all children in this country. That motivated me to lead a seven-year, grant-supported program to work with elementary school teachers and children in nine New Jersey districts, including Newark, Paterson, and Passaic. I share some disturbing, startling stories about this time as well as some stories of remarkable success. Recent admonitions to "raise standards for all" motivate a personal story about my mentally retarded brother; he and I needed and were given very different types of education. I then offer nine reasons for promoting mathematics education for all, three things good teachers need, and a few more suggestions for improving equity and education. The paper includes photographs and references to important books.

Progress is possible!

When I graduated from college in 1961, five per cent of the doctorates in mathematics in this country went to women. It is now about thirty percent. Progress is possible. However, the spring issue of Ms. magazine reports that there has been no progress for women in the STEM fields in the twenty-first century [16]. More progress is needed.

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Back in 1971, I was overjoyed to see a letter from Mary Gray in the *Notices* announcing the formation of an Association of Women in Mathematics. I have been a member ever since. When I had the opportunity to attend my first national math meeting, I searched out the AWM desk. Mary Gray recognized my name! I was astounded. She said she knew something about all the American women with doctorates in mathematics. "There are fewer than a thousand of us."

Figure 1: Mary Gray.

African American Mathematicians

I went to the summer 1977 AWM meeting and they asked for a volunteer to organize next January's AWM panel. I raised my hand. Competition was lacking, so I had the honor. What shall the topic be? Judy Green piped up. "Black Women in Mathematics"

Figure 2: Lee Lorch with Grace and Alice.

"The empty set?" asked a voice.

Lee Lorch stood up immediately. "NO! It's not the empty set! The Meeting will be in Atlanta, and I think it's a very appropriate topic!" He began listing names of African American women mathematicians. I agreed to organize the panel, and my life was changed.

The January 1978 panel had five members. Someone said at that panel that there were twelve African American women with doctorates in mathematics. Writing them up sounded manageable and worthwhile, so I sent letters to the names I had. Lee Lorch had told me that the first two were Evelyn Boyd Granville and Marjorie Lee Browne, who both earned their doctorates in 1949. Dr. Granville immediately responded to my letter with a fascinating one of her own. That inspired me to telephone Dr. Browne.

Figure 3: Evelyn Boyd Granville on the left and Marjorie Lee Browne on the right.

"Why are you doing this?" she asked repeatedly. "Why are you doing this now?" I told her she had made history and I wanted to record how it had happened. She promptly sent me a copy of her vita. Less than two weeks later she had a heart attack and died. I now seemed to be the only one who could interview all African American women with a doctorate in mathematics. I found more by "networking." In those days before the web, this meant writing letters and making phone calls and asking each person if she knew others.

Figure 4: Euphemia Lofton Haynes.

By the time my paper was published in the October 1981 *Monthly* [6], I could list twenty black women with doctorates in mathematics. I quickly learned of four more. One sent me a check for $40—a lot of money in 1982—for giving her a peer group. She hadn't known there were any others, which is why I had not reached her by networking. Two decades later Scott Williams and Bill Hawkins independently discovered that the first African American woman to earn a doctorate in mathematics was actually Euphemia Lofton Haynes [9, pages 93–97], who earned her degree in 1943 but didn't know any of the others. She died shortly before my *Monthly* paper was published.

A few years later the media had articles asking why there were "no" black mathematicians. I had contact information for quite a few former students by then and thought it would be interesting to study black mathematicians of New Jersey. This time I would define "mathematician" as someone with a degree in mathematics or who worked primarily as a mathematician. I obtained two courses of released time in consecutive semesters to explore this group via networking, starting with my former students.

In the mid 1980s I located a hundred and fifty black mathematicians in New Jersey and received seventy-five responses. You can read a summary of my findings in my book *Change is Possible: Stories of Women and Minorities in Mathematics* [9, pages 104–109].

One response changed the course of my career. I asked what can be done to bring more blacks into mathematics. The number one answer was, "Teach mathematics better to all American elementary school children. The way it is now if you don't learn it at home, you don't learn it at all so any ethnic group that is underrepresented will remain so until our elementary mathematics education is improved" [10].

Elementary School Teachers

From 1988 to 1995 I won fourteen grants to direct and work in a program to help elementary school teachers mathematically in nine New Jersey school districts, including Newark, Paterson, Passaic, five middle class districts, and one of the richest districts in the state. I made four major discoveries. The teachers knew appallingly little mathematics. They were very eager to learn–without exception. They were all plenty smart enough to learn at a high level. They were angry when they realized the extent to which they had been deprived. One memory stands out.

Using base ten blocks it is easy to teach why the two-digit algorithm for multiplication works. For example, 23 times 31 can be constructed as a rectangle, as in the right-hand side of Figure 5. We can directly see the four numbers that appear in the algorithm: 1×3, 1×2 tens, 3 tens $\times$ 3, and 3 tens $\times$ 2 tens. This requires more lead-up for children and their teachers than it may for you, but within an hour they can do this. I have taught this to hundreds of third graders apparently without failure in the sense they all said they understood when I left the room.

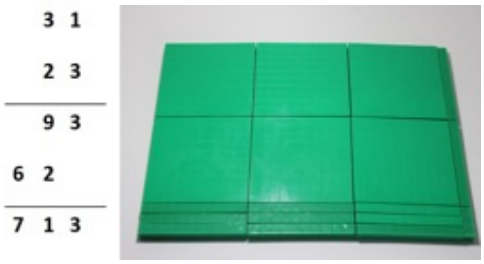

Figure 5: Why (the two-digit algorithm for) multiplication works.

After I presented this to a group of teachers, one asked me, "Why wasn't I told this secret before?" I was uncharacteristically speechless, so she stood up. "Did you know this secret before?" she demanded of each of her classmates. All said they had not. She turned on me.

"Why wasn't I taught this secret before? I've been teaching third grade for thirty years, and I could have been *such* a better teacher if I had been taught this thirty years ago!" I became a rectangle advocate.

Figure 6: Squaring $x + y$.

In my first venture into an elementary school as a mathematician, I gave an after-school workshop to the school's teachers. I thought I would motivate $(x+y)^2$ and drew the picture in Figure 6 on the board. First I labeled the shorter line segment x and the longer one y so that each side of the big square would be $x+y$. Next I pointed out the squares with area x^2 and y^2. Then I asked, "What is the area of a rectangle that is x long and y wide?" There was a long pause. Then two helpful teachers said simultaneously, "x plus y?"

"What?!!" I recoiled in horror.

Over twenty teachers called out in unison, "x plus y." Friends, we have a serious problem. However, we also have the remedy. That year that school's three third grade classes all had a median of the 25th percentile on the old-fashioned Iowa standardized tests. Three years later two of those third grade classes had achieved a median of the 60th percentile, well above the national average. The third had a median of the 70th percentile, with only one child below the 50th and that one was around the 40th. Progress is possible.

This was achieved by the collaboration of the teachers and me. When we started, I had no experience with elementary school classes, but they helped me. They were fine teachers, but they had not known the third grade curriculum well enough to convey it before.

Unfortunately, the problem begins before third grade. I started working in a first grade late one October. The standardized test given in November included subtraction, but the teacher assured me that was too hard for her students. None had ever passed the subtraction part. She focused on addition, so they could pass that. I said I would teach both. She said she would not reinforce my work, and I said "okay."

I held five Unifix blocks in front of the class and asked them to hold up the number of fingers to match. They all could. Then I put them behind my back and brought forth two. How many were behind my back? All put up three fingers.

"How do we write this?" I asked "There are several ways." First I wrote $2 + 3 = 5$. Then I wrote $5 - 2 = 3$. We could see two blocks, so there must be three still behind my back.

"Oh, no!" said the teacher. "Subtraction means takeaway, so it must be written $5 - 3 = 2$." I explained that subtraction can also mean missing addend. Then I explained the difference meaning of subtraction and the motion meaning. "If you have five and I have two, you don't need to take away my two to know you have three more. If I walk five steps this way and two steps back, I am three steps from where I started." I came two more times before the standardized test, and a majority of the children passed the subtraction part! The teacher assured me she had not mentioned subtraction, so on the basis of three separated half-hour lessons, a majority of the children passed a subtraction test, from the same pool where none had before. Progress is possible.

I kept going to that first grade on Wednesday mornings the following semester and taught a graduate abstract algebra class on Wednesday evenings. I found myself saying repeatedly in the abstract algebra class, "When we were discussing this idea in first grade this morning..." At first we all chuckled, but we got used to it. As she handed in her final exam one student said, "I think we learned a lot more this semester because you were also teaching first grade." The others nodded emphatically. When I graded their finals, the lowest grade was the same as the second highest the previous time I

taught the course. I doubt that I made the exam any easier. Those first grade concepts are basic, and children ask deep questions.

After a few years of working with elementary children and their teachers, I found myself saying repeatedly, "It matters less what deck you are on when the whole ship is sinking." I believed then and now that two "ships" I am on are sinking. One is our math educational system, based on elementary school teachers who have not been taught the mathematics they should teach. The other is the environment, in particular climate change.

The possibility that the climate is changing so rapidly that people may not be able to adapt is too terrifying to address here. My own major response, other than organizational and political activity, has been to show and tell how I raise all my family's vegetables year round in my back yard with no power machinery or poisons twelve miles from Manhattan. If you would like to be on my gardening/environmental email list, just email me. It's a small thing, but satisfying. Progress is possible.

However, my struggle to help all elementary school teachers learn the math knowledge they need has been remarkably unsuccessful compared to other efforts. So I hope that others may be able to give me useful suggestions.

Why have I been so unsuccessful?

One reason may be that I naively thought that others would agree with me. Certainly, I overestimated the math knowledge of adults. Two education professors said to me, "I got to be a full professor without knowing how to find the area of a rectangle. Why would you expect third graders to learn that?" I now realize that third graders learn these concepts a lot more easily than teachers and education professors, who have lived much longer with the results of a faulty mathematics education.

In my anger, I have been known to say that education professors seem to want children not to learn any more mathematics than they already know, which puts a very low ceiling on children's achievement. That sentiment probably has not served me well. I retired after almost twenty years of trying unsuccessfully to get a math course for elementary school teachers instituted at Montclair State.

After retirement, I was able to introduce such a course at nearby Bloomfield College and teach it four satisfying times using the wonderful Singapore

texts.[2] Many have told me that Sybilla Beckmann's text *Mathematics for Elementary School Teachers* [1] is excellent, so there are at least two fine texts available to make you an instant expert if you get the opportunity to teach future elementary school teachers—hopefully with a summer of preparation.

I'd thought that, with the extra time I had after retirement, I might help pass a state regulation that future teachers be taught at least one course in the mathematics they are supposed to teach. I was told by someone in a position to know whose identity I should not reveal that a dozen deans of education in New Jersey oppose my effort to get a math requirement for future teachers.

Why Care about Equity and Education?

Let's turn now to the "why" in my title. There are at least three reasons to want to improve equity.

The obvious one is ethics. There is no moral justification for favoring one human being over another on the basis of irrelevant details like race or gender. I believe all leading religious and moral leaders have agreed.

Another reason to promote equity is to live in the kind of country and world that we want. If everyone has appropriate work and other activities and is well prepared for that work, we all benefit.

Thirdly, I believe that our math community has become more pleasant for all since the barriers have been lowered for women and minorities. My impression is that our white males enjoy having the rest of us around. They certainly seem happier than when I first came to meetings. We have a way to go, but the progress during my career is gratifying. Progress is possible.

The reasons I care so much about education is more complex. It is essential for equity, which is why I became so deeply involved.

There are at least eight other reasons to improve math education in this country.

So much has been written about the importance of mathematics for our country's international competitiveness and for careers that I will not elab-

[2]For less than $50, one gets the main text [13] and four children's paperback texts used in Singapore.

orate on it here, except to say I agree. Alas, I will add that I've known too many math professionals having trouble getting jobs in northern New Jersey, in particular as high school math teachers. Our economy recently appears to be another sinking ship, but the solution is not as clear to me as for education and the environment.

Most readers of this *Journal* studied math at least partially because we find it so much fun. It brings many others pleasure too, as evidenced by the widespread popularity of Sudoku and Ken Ken recently.

However, not everyone enjoys mathematics, so it helps to have other selfish reasons.

Psychologists tell us that discomfort with mathematics undermines self-confidence. So it can be argued that knowing mathematics increases inner comfort, even if it doesn't generate outright pleasure. It's more widely acknowledged that mathematical knowledge fosters personal financial security. For example, in our nearby supermarket, a package of 8 bars of Irish Spring soap sells for four dollars. In the nearby convenience store it is $1.29 a bar.

Cinnamon Hillyard and Peter Nye have investigated the relationship between math and personal debt in detail [5]. In their work they distinguished between quantitative literacy and subjective numeracy. The latter is, loosely stated, enjoying the quantitative skills one has and having the confidence to use them. Enjoyment of mathematics matters! People who don't enjoy math might buy soap at the convenience store.

Let us look at the specifics of their study. Hillyard and Nye won a grant to distribute a carefully crafted eighteen-page questionnaire to about three hundred subjects, each of whom received $20 for participating. Two pages of the eighteen-page questionnaire consisted of math questions. The others explored more subjective themes. Half of the subjects were college graduates and almost ninety percent were high school graduates. Each gender was approximately evenly represented.

Analyzing the results of the data they gathered, Hillyard and Nye concluded that materialism has little influence on the tendency to go into debt. It is lack of subjective numeracy along with compulsive consumption that leads people into overwhelming consumer debt; see [5] for more details.

I suspect that teaching elementary children mathematics competently will lead to less crime and drug usage. I watched young children having their questions repeatedly squelched by unprepared teachers who didn't hear the

profundity of the children's questions. I remember well one day in a Paterson third grade when the teacher kept saying, "The children won't pay attention." I raised my hand. I was supposed to be an observer, but I volunteered to answer the children's questions. "Yes, but they won't pay attention to you either."

Perhaps it was just to prove their teacher wrong, but they all did pay attention to me for an hour. I taught them division. They had never had division before. I taught them fractions. They had never had fractions before. I taught them division of fractions and then invited them to consider the limit of 60 divided by x as x goes to zero. We believed they all followed this when I left the room.

I had the nerve to do this because of an experience in a Newark third grade. When I went into that third grade, the teacher said in front of her thirty-one students, "Can we put aside the lesson you and I planned and you just answer the questions of the children that I can't answer?" In the following hour I taught that class division, fractions, division of fractions and a bit about limits. Both classes were all black children. The Newark class was in the poorest part of what was then the poorest city in the country. How frustrating it must be for children to have their deep questions ignored, possibly with no relief at home!

Frustration and put-downs lead to unwise choices. I believe that empowering elementary school teachers to converse deeply about basic mathematical ideas will mean that fewer of their pupils will later turn to drugs and crime.

The relationship between mathematics and the environment is evident in many ways. I wish the graph in Figure 7 below, showing the relationship between the increase in carbon dioxide proportion in the atmosphere and the average global temperature, were more widely publicized, for one.

More generally mathematics is needed for better citizenship. Facts are out there [2, 3, 8]. Mathematics can help us make sense of these facts, so we can make the necessary decisions and meet the challenges we face.

Individual Differences

Does all this mean that I believe there should be a standard curriculum for everyone? I have nothing against the Common Core State Standards, but people vary greatly.

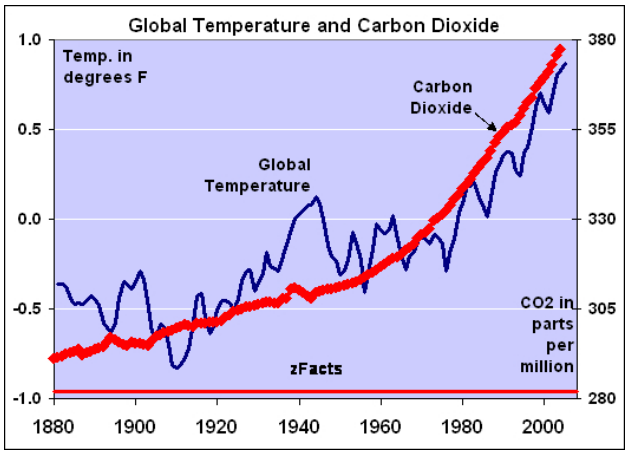

Figure 7: Global temperature and carbon dioxide; graph from http://zfacts.com/p/226.html, accessed on January 6, 2014.

This spring I heard Nel Noddings speak at Montclair State, her alma mater. Nel was a high school mathematics teacher who became a Professor of Education at Stanford University and then president of the National Academy of Education. She argues convincingly that American youngsters should have far more choice than they do now to take courses according to their interests and abilities. She observed that the roof of her house had been greatly disturbed by Hurricane Sandy, and her mathematical knowledge does not empower her to repair it. She needs help from someone with other skills. Sandy also disrupted the working of my solar panels, so I had a similar need for someone with skills that I don't have, but does need not know the quadratic formula.

During her talk and in her 2013 book *Education and Democracy in the 21st Century* [12] Nel Noddings protested a recent popular slogan, "Everyone can learn mathematics." I was so glad to hear this. She gave me courage to speak out on this issue.

When I was seven and my brother was four, his IQ was diagnosed as 50. We could see he was not nearly as smart as the Downs Syndrome children with whom he played. In those days if a woman had a handicapped child, society said it was a punishment from God for her sins and she should pay by having no more freedom while she took care of that child. My mother decided she could not believe in a God so cruel that he would do this to a child for her sins. She spent much of the next five years organizing parents.

Figure 8: Bruce and Patty in 1954.

In 1952 New Jersey became the first state in the country, and I think in the world, to pass legislation saying all children must be educated at public expense no matter how handicapped. Progress is possible.

The two prime movers behind this legislation were my mother, Bertha Francis Clark, and Elizabeth Boggs, who studied mathematics with Emmy Noether at Bryn Mawr. I watched two women start the special education movement. Progress is possible.

Bruce held a regular full-time job from age 19 to 65. He made over $\$18,000$ only once, when he was 64. Today my brother lives alone in his own efficiency apartment and has a comfortable retirement at his own expense. Progress is possible.

When he was a teenager, Bruce told my mother that he wanted to learn long division. Mother was doubtful, but Bruce was insistent. They worked at it all summer and then he could do long division. However, the story was different after he told me when he was an adult that he wanted to learn algebra. I'm good at teaching algebra, but after working at it hard together, it became obvious to both of us that he wasn't going to get the hang of adding signed numbers.

Testing, Homework and Charter Schools

In complete contrast to Bruce are *all* the dozens of elementary school teachers to whom I have attempted to teach mathematics. Once a fluke resulted in my being assigned to teach twenty-five Newark third grade teachers I had never met before for an entire day. They were told to prepare lessons

for their substitute and go to a different building to spend the day with a mathematics professor. I thought it might not be a good day.

But it was a wonderful day for me and I didn't detect any unhappy teachers. I prepared a different math lesson to begin every forty minutes. We can reach elementary school teachers. I have never met an exception. Progress is possible.

In mid-morning I gave them a break. At the end of the break one of them approached me with a copy of the recent standardized test they had all administered to their third graders. "None of us can do this problem. Can you show us how?" I could and did. Meanwhile, the reaction of the other teachers was interesting.

"Where did you get that test? We had to return our copies right after the test."

"We could see the test only while administering it."

"We couldn't see it at all. We had to administer the test to children in another grade." These were all from the same district.

How anyone can believe that any high-stakes decisions should be based on standardized tests baffles and distresses me.

Twenty years ago psychologists were warning that cheating on tests becomes rampant as the stakes become higher. A recent report indicates that there is confirmed cheating in at least thirty-seven states; an accompanying press release lists several ways in which test scores have been manipulated in cities such as Atlanta, Baltimore, Cincinnati, Detroit, El Paso, Houston, Los Angeles, Newark, New York City, Philadelphia and the District of Columbia:

- Encourage teachers to view upcoming test forms before they are administered.
- Exclude likely low-scorers from enrolling in school.
- Drill students on actual upcoming test items.
- Use thumbs-up/thumbs-down signals to indicate right and wrong responses.
- Erase erroneous responses and insert correct ones.
- Report low-scorers as having been absent on testing day.

"These corrupt practices are inevitable consequences of the politically mandated overuse and misuse of high-stakes exams."[3]

We continually hear about corruption in government and business. I personally believe that teachers are more honest than average people, but the temptation for cheating is very high on high-stakes tests.

Furthermore, there are no certification requirements for making up standardized tests; see the cartoon by Mary Fordham on page 222 of my book *Math Power: How to Help Your Child Love Math Even if You Don't* [7] for a humorous perspective on this. Anyone can do it, with no accountability [4].

Even our best testing services make mistakes, as evidenced by the successful suit of students against the ETS, showing that some expected answers were not correct.

I believe the worst effect of high-stakes tests is the extent to which they undermine education. Test-prep is very different from education. When the effects of high-stakes standardized tests in New Jersey could be seen, I noticed a significant drop in my liberal arts students' mathematics preparation.

Steve Willoughby, a former NCTM president, in his fascinating book *The Other End of the Log* [17, pages 161–163], relates that when he was a high school teacher in Illinois, he was told that his students had to achieve higher grades on standardized tests. He abandoned good mathematics teaching, and his students rated highest in the state the next administration. But he knew his students had not learned as much mathematics as the previous group.

The long-term effect of testing might be indicated by China's experience. China has long had a system of high-stakes standardized testing. Their students are good at taking tests, but I read that they are asking themselves, "Why does China not produce any Nobel Prize winners in the sciences? Why doesn't China produce innovative entrepreneurs like Steve Jobs and Mark Zuckerberg and Bill Gates?"'[4] I fear for my country's future if we continue our obsession with testing.

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[3]For the rest of the press release and the report itself, see http://www.fairtest.org/2013-Cheating-Report-PressRelease, accessed on January 6, 2014.

[4]See for instance the recent op-ed written by Jiang Xueqin, deputy principal of Tsinghua University High School, on the success of Shanghai students in international tests, available at http://www.cnn.com/2013/12/04/opinion/china-education-jiang-xueqin/, accessed on January 6, 2014.

In contrast, Finland has achieved comparable scores on international math tests by "improving the teaching force, limiting student testing to a necessary minimum, placing responsibility and trust before accountability, and handing over school- and district-level leadership to education professionals." A recent book [15], written by the director general of the Centre for International Mobility and Cooperation at the Finnish Ministry of Education, emphasizes that Finnish teachers have high prestige, they undergo very competitive teacher-preparation, they receive much autonomy, and they have to deal with no standardized testing.

If we want to encourage teachers to be better, what should society do? I hereby postulate that all teachers need three things: subject matter knowledge, kindness, and freedom. The first permeates this entire talk.

How could anyone be against kindness? Still, we have a problem. One math professor had a student approach him after a few classes. She said, "I'm so relieved. When I saw how fast you solve problems, I became very worried. I thought all smart people are mean."

An MAA member who is a department chair asked me to appeal to you to hand back tests, so students can contemplate their mistakes alone and with friends and learn from them. Seeing the paper in the professor's office is not the same. It seems basic kindness to students to return their corrected papers. Admittedly, I have been known to copy some first in special circumstances.

I suspect that the problems of kindness in the classroom are no worse than ever, but recent curbs on teacher freedom are truly frightening. Tenure has been our defense over much of the past century, but in a recent AWM newsletter, Mary Morley tells us that thirty years ago over 45% of college professors had tenure and recently less than a quarter do [11]. Similar threats face K-12 teachers, augmented by sudden changes in their assignments, making it very difficult to learn the subject matter and prepare in other ways. One kindergarten teacher my husband knew was assigned one August to teach remedial high school math the following year, which she knew she didn't know.

High-stakes standardized tests are an increasing threat to teacher freedom. I applaud the Seattle teachers who united in refusing to give standardized tests.

Requiring teachers to assign homework is also pernicious. As children's freedom is thwarted, teachers' is too. Children should play, explore nature, and enjoy friends and family.

I had no homework until seventh grade. Homework was a status symbol. Big people had homework. Now our youngsters are all homeworked out by the time they can benefit from doing it. When I started teaching at Montclair State in 1973, I believed that most of my students did most of their homework most of the time. That changed.

A sociology professor at a nearby teaching university told me he had supervised a class using careful statistical methods to ask students at that university how much time they spent doing homework. The median time per week was five hours. "And most of them are taking twelve hours of credits," he winced.

I see the charter school movement as a response to the increasing denial of teacher freedom. However, charter schools take children of motivated parents away from other children, who need them badly. I believe that both Presidents Bush and Obama meant well, but I also believe they both have done a lot of harm to our children's education through promoting high-stakes testing and charter schools, respectively.

Better than charter schools is the "magnet school system," instituted in Montclair, New Jersey, in 1976. In this system all parents must choose their children's public school. One public school is a Montessori school, one an international school with children of 20 native languages. One is a math-and-science school, one a computer-based school, and one a performing-arts school. Of course, parents are free to choose the nearest school.

The magnet school system has the advantage of involving all parents, not just the highly motivated parents, whose children are desperately needed by the others. After years of being in a variety of schools, I strongly believe there are many viable approaches to education. What matters is that the adults in one school agree. If staff and parents are arguing among themselves, children's education suffers terribly. The magnet system enables groups of teachers led by a simpatico principal to teach as they think best. All Montclair schools have a loyal following.

What Can Be Done?

So what do I believe the mathematical community can do to improve equity and education? Most important is to help present and future elementary school teachers learn the mathematics we expect them to teach.

Secondly, we surely need to communicate better what we perceive mathematics to be. Misunderstandings of mathematics are doing lots of harm.

When David Boliver was counseling students about taking remedial mathematics, he was often told, "I'm no good at mathematics."

His routine reply was, "If you were good at mathematics, how would you be different?"

"I would just look at a math problem and know immediately what to do." Friends, we have a communication problem.

Perhaps our best interpretation of mathematics for the public is the book *Innumeracy* [14] by John Allen Paulos, an AMS member at Temple University. *Innumeracy* was a best-seller in 1988. He says that more mathematicians should write for the public. Who can oppose that? We need to explain better what mathematics is.

We need to address publicly the curse of keywords. Did you know that children are taught that "altogether" means add, "left" means subtract, and "each" means multiply? During the last class in a liberal arts course one of my Montclair State students insisted that because the average mileage of family-owned small trucks in 1990 was 20 miles per gallon and the average of sedans was 28 miles per gallon that altogether their mileage must be 48 miles per gallon. After I explained three times and three of her classmates made fine explanations, she could see she was outvoted, but she had always been taught that "altogether" means add.

She was a nice person in her very last math class before she became certified by Montclair State as an elementary school teacher. A few years later Montclair State was honored as one of the top ten best teacher preparation institutions in the country.

More recently I have been informed that the Kaplan test-prep series tells its readers that when you see "each", you multiply. If a mother has six cookies and she wants to give an equal number to each of her two children, apparently she must give each twelve cookies. Poor Stanley Kaplan must be screaming in his grave.

One day when I taught pre-service elementary school teachers at Bloomfield College, I said yet again, "Do not use keywords!"

A student responded, "Then how are we supposed to solve problems?"

"You think about them." She looked at me as if I had sprouted horns.

"Yes, you can think about them," I insisted. We talked our way through that problem and I reveled, "See! You can think." For the rest of the semester I would say, "You are thinking again," and she would smile.

More generally, we need to oppose teaching wrong mathematics. Subtraction is not just takeaway. You can subtract a larger number from a smaller number. Fractions are far more than a part of something. Our definition that a fraction is the answer when you divide two whole numbers is just as understandable for young children, and doesn't have to be unlearned when students meet improper fractions. Remedial work is expensive and much harder than teaching correctly the first time.

Can we tame standardized tests? Whether mathematical organizations want to wade into this territory I don't know, but individually, we can.

And what about equity? In 2013, MathFest, the annual summer meeting of the Mathematical Association of America (MAA), had nine plenary speakers, five women and four men. One of each gender was African American. The MAA has gone far in diversifying the all-white-male club it seemed to be when I first joined. We need to improve both gender and racial equity, but progress is not only possible, it has been made during my career.

I am, however, very worried about our educational system. We must raise the level of elementary school mathematics education.

Three Stories

Let me conclude with three true stories with different morals.

I was first assigned to teach a course of mathematics for liberal arts after I was tenured. By then I was questioning the value of testing. Why give tests in a terminal course for liberal arts majors?

I decided not to give any tests, quizzes or exams. Instead I required a 200-word essay every week on what they had learned that week. These are much more fun to grade than quizzes! On the other days the students were required to hand in a question on the reading, which guided what I did in the classroom. They also wrote a five-page term paper and a three-page final paper. During the two-hour required final exam time we put the chairs in a circle and each student spoke about the experience of taking the course, including explaining one topic that they had learned.

One memorable time a mature woman was first. She told us that this was the first time she had ever enjoyed a math courses. "When I was a child, the nuns rapped our knuckles whenever we got a wrong answer." She began to collapse into uncontrollable sobs, and the class's eyes clouded. The room was intense with silent sympathy.

Next was a college-age student. She said that she had gone to a public school where physical discipline was illegal, but the public humiliation was terrible. As she told about it, she began to sob gently, and we all sat sadly but less emotionally than before.

Next another college-age woman began to tell about her elementary school math experiences, and soon tears were streaming down her face. I heard some giggles around the room. "Group therapy in math class!" someone quipped and we all smiled, including the one with tears.

The next in the circle was a young man, a big, hulking football-player-looking type. Surely he would break the trend. But no. Soon tears were appearing as he told us of his previous math class experiences.

How representative is this of American students' memories of math class? I have no idea, but we all know the common shudder after someone asks us what we do or major in.

This summer a neighbor told me about his son's experience in a Montclair public school The teacher told the class that $1/2 + 1/2 = 2/4$. One child raised his hand and observed that $2/4 = 1/2$.

"No," said the teacher. "We leave the large numbers." Montclair has the reputation of being one of the best public school systems in the country, and I suspect deservedly. Our graduates excel at the nation's best institutions of higher education.

Finally, a first grader in one of "my" Newark classes had talked about mathematics with an adult. She reported to me that he told her solemnly, "Little children count. We look for patterns." (cf. the cartoon by Mary Fordham on page 43 of [7]). Progress is possible!

Photo credits: The photos in Figures 1–4 and 9 are from the author's personal archives.

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