Mathematicians and Mathematics Educators Must Be Political!

All mathematical people, mathematicians, and mathematics educators must come together politically if the mathematics discipline is to survive. This reality has begun to permeate the visions of some in our community but must still come to the forefront for others.

The No Child Left Behind Act (NCLB, 2000) has as bases: every child must have access to a quality mathematics education, and every child has the right to be taught by a "highly qualified teacher." These bases are consistent with the Principles and Standards for School Mathematics (NCTM, 2000). However, implementation of the act has become highly problematic and points to a need for action.

To promote mathematics in this climate, NCTM (2003) adopted a political advocacy program that can be supported by all mathematical people in a proactive stance for the discipline. Planks include the following:

Equity. Every child has the right to be taught by a highly qualified teacher of mathematics, one who is knowledgeable in content, understands how students learn, and uses appropriate instructional methods. Every child must have the opportunity for the mathematics education required for an economically secure future, and no single test should limit future opportunities to learn mathematics.

Teacher Quality. All mathematical people must work to develop multiple effective routes to certification of highly qualified teachers. All routes must include strong mathematics content, knowledge of student learning, appropriate instructional methods, mentoring, and classroom experience.

We must ensure that teachers of mathematics (including postsecondary) commit to career-long professional growth and find support for the allocation of resources to achieve this goal. This means that (1) each beginning teacher needs a professional development plan for the future when they complete programs of study; (2) adequate federal funding continue for the National Science Foundation (NSF) for the support of innovative programs of professional development of mathematical people; and (3) proposals for NSF programs continue to be open to all to apply, to be peer reviewed, and to be of the highest intellectual content.

Research. All mathematical people must continue to improve the teaching and learning of mathematics, realizing that the complexity of schools and school systems requires the use of a variety of research methods—both quantitative and qualitative. We must teach the public that mathematical education research is not equivalent to medical research and cannot rely on commercial ventures for the research.

Significantly increased funding for research about student mathematics learning, curriculum materials, and effective classroom practices is necessary. No publisher, individual state, or school system can finance the scope and type of research needed to improve mathematics learning and teaching. Financing of the type used to produce the standards-based precollegiate curricula needs to be supported as innovations by NSF and the U.S. Department of Education.

Additionally, research on the impact of policies at all levels on school mathematics programs and on closing the achievement gap must be supported. Currently some NCLB policies may lead to increasing, not solving, problems in mathematics education.

Assessment. All mathematical people, teachers of mathematics, schools, students, families, and communities are together accountable for student achievement in mathematics. As responsible persons and institutions, we must work together to understand success and for whom, and when we are less successful, with whom. These ends require governmental resources for the development of new, accurate, and powerful tools to measure student learning of mathematics.

While supporting testing, we must guarantee that all testing be used only to improve student learning, not to limit access to future mathematics. Many adults come to mathematics late; we must do everything possible to keep access to mathematics open as long as possible for as many as possible. We should also remember that continual testing alone is no guarantee of learning.

Technology. All mathematical people must endorse the inclusion of and access to appropriate technologies, for all students, as part of a balanced mathematics curricular program. All should support teachers' use of innovative technologies that offer students better ways to learn mathematics for future study and the workplace. All must learn how mathematics at all levels has changed as a result of technology; all must consider what mathematics is now accessible that once was not and act accordingly.

We must support allocation of funds to provide all teachers of mathematics the time, training, and resources to incorporate technology into the learning environment.

Teacher Shortage and Retention. All mathematics people must work to attract and retain teachers of mathematics, elevate the status of the profession, and improve the working environment. We must attack incorrect public perceptions about mathematics and its teachers in the media and in the legislatures. It is time that we accept no bias against those who teach, study, and learn mathematics.

Can we as mathematical people afford not to promote mathematics with the platform outlined if our discipline is to survive?

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Letters to the Editor

A Theorem of Bartle

In connection with the obituary of Robert G. Bartle (*Notices*, February 2004, page 239) I wish to draw attention to his beautiful paper "On compactness in functional analysis", *Trans. Amer. Math. Soc.* **79** (1955), 35–57. The paper is so nicely written that any beginning graduate student can follow it, and yet with the use of simple techniques, he derived several deep results as special cases.

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Term Copyrights

In his discussion of copyright and scholarly journals (*Notices*, March 2004, page 309), John Ewing puts up some good arguments for the shortening of copyright terms. However, he sounds somewhat uncertain as to whether even his "Modest proposal" (28 years of protection, as it was in the first copyright law of 1709) can be realistically implemented any time soon.

I think the situation may be more promising if we do it in steps. As we are presently witnessing from the on-going fierce downloading battles between the record industry and the millions of music fans ("pirates"), social opposition to the present Draconian intellectual property laws is rising. Similar tensions are mounting around ludicrously broad patent laws, where excessive and frivolous patenting and numerous lawsuits often suppress technological innovation.

The scholarly community versus academic publishers is somewhat less visible in this debate, but many scientists view copyright as a nuisance. It brings almost no real benefit to them while seriously complicating (and often blocking) their access to archival literature. With relatively few exceptions of scientists publishing commercial books for the general public, the academic community has no real need for copyright. All we need is a reliable mechanism for establishing the authorship of scientific writings. Copyright is not essential for that.

Recognizing that copyright cannot be abolished overnight, my proposal is that publishing scientists should try to copyright their papers for a fixed, specifically indicated, short term, say for five or ten years. A copyright notice looking like "© 2004–2009" would mean that in 2010 the work enters the public domain. Even sporadic attempts of this kind may trigger an unstoppable trend.

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Teach More Math K–12

Anthony Ralston says much that is valuable and a few things that are doubtful ("Research mathematicians and mathematics education: A critique", April 2004, pages 403–11). I praise what is valuable in general and comment on what seems doubtful in particular.

Everybody knows what is wrong with K–12 education. To demonstrate this, carry out the following experiment. I have done this experiment many times with many different kinds of groups. Ask an audience to write down the one word that they imagine a K–12 student would use to describe their educational experience. Then ask the audience to say that word out loud. The word, even the pronunciation, comes as a chorus: Booooooorrrrrrring!

The problem with K–12 education is that it teaches too little. The students are not challenged. They complain that they are treated like babies. They report that their teachers go over and over material that almost everyone in the class already knows and that the people who don't already know the material aren't listening. They say that busywork and daydreaming, not learning, make up the larger part of their school day. With this as a starting point, the system is unlikely to be improved by removing subjects from the curriculum.

Ralston supports the controversial position that we should remove long division from the curriculum. He points out, correctly, that there are other division algorithms that work just as well. This misses the point. The point is not which algorithm to teach but whether to teach any algorithm at all. What is the advantage in not knowing how to do long division? Students like to know how to do things. Taking long division out of the curriculum accomplishes nothing. Is long division a waste of time? I don't think so. But since we are already wasting most of their time for twelve years, I don't think the time saved by not teaching long division represents an appreciable saving.

More generally, Ralston expresses doubt about the usefulness of teaching any pencil-and-paper arithmetic. I use pencil-and-paper arithmetic all the time. I balance my checkbook while waiting in line at the bank. I play around with figures to get a feel for what minimum bid to list for an item on eBay. I do pencil-and-paper arithmetic on a plank before I begin to saw. What is the advantage in not knowing how to do pencil-and-paper arithmetic?

We need to teach more, not less. Teach mental arithmetic, pencil-and-paper arithmetic, calculator arithmetic, manipulatives, estimating, proofs, and word problems. The key word is "more". We need to teach more, not less. I am at a loss to understand people who recommend teaching less.

In my experience, students who cannot do pencil-and-paper arithmetic cannot do calculator arithmetic. I see more and more such students. Typically they are indifferent as to whether they push the plus button or the times button. It's all the same to them.

Each year fewer United States citizens get Ph.D.'s in math, science, and engineering than the year before. If we stop teaching pencil-and-paper arithmetic, we will not only have too few Ph.D's, we will have too few carpenters and plumbers.

Ralston's call for civility in the math wars I praise. When he slips into taking sides in the math wars, and he does (most clearly on pages 407–8), he loses me.

Teach more, not less.

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Tutte and Beraha

We enjoyed reading the biographical sketch of William T. Tutte by Professor Hobbs and Professor Oxley in the March 2004 issue of the *Notices*. It was well written and comprehensive.

However, it seems to us that any discussion of chromials (chromatic polynomials) and their zeros ought to make mention of the Beraha numbers

$$B_n = 2 + 2\cos\left(\frac{2\pi}{n}\right)$$

and the Beraha conjecture, which states that for every n, B_n is the limit of zeros of an appropriately chosen family of chromials. Note that $B_5 = 1 + \tau \cong 2.618$, where τ is the *golden mean* equal to $\frac{1+\sqrt{5}}{2}$. Sami Beraha did prove his conjecture for B_5, B_7, and B_{10} by inventing appropriate families of planar graphs.

Professor Tutte not only mentioned Sami Beraha's conjecture several times in print but he was also the one who first named it "the Beraha conjecture" and called them "Beraha numbers". Professor Tutte and Sami had a long-standing relationship and were frequently in contact.

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Is Research in Mathematics Education Scientific?

Anthony Ralston berates in the April issue of the *Notices* the hubris and arrogance of research mathematicians who look down upon research in mathematical education. In view of the fact that the notion of the scientific is repeatedly used as a club to wield, it would not be amiss to remind ourselves of the basic criteria. Such criteria have been around for a long time, but they seem not to have been presented in explicit enough form. Three things characterize a scientific endeavor, namely:

1. A presence of a theory, which provides a general structure and in particular serves as a guide to what questions to ask and how to interpret answers and observations.

2. A methodology including tools with which problems can be addressed.

And finally, the sore point:

3. Confirmations to anchor the activity to reality.

This means in effect that a consensus can be made and in particular allows an outsider to judge. (The operation may have been successful, but the patient died.) More provocatively, recall Popper's dictum of science being an activity which is constantly trying to falsify itself.

So it would be a good exercise to think how mathematical education fares when viewed under (1), (2), and (3). I think especially (3) has been a problem for many mathematicians. Where are the results of mathematical education, results which we can ignore only at our peril?

Of course there are lots of worthwhile activities that do not satisfy these criteria, but most of these do not seek legitimacy through claiming scientific status. Thus in the absence of a true science of teaching and education, we have to resort to the notion of it being an art. And what is so terribly wrong with that? So my point here is not that teaching should be denigrated as being an elementary activity (although some educators have made grandiose pronouncements to the effect that the discipline eventually will clarify the nature of mathematical thinking per se) but that it is ill-served by claims of a spurious scientific legitimacy. In fact, in previous issues of the *Notices* some mathematical educators have warned against the "scientificism" of their discipline.

Thus I do not view mathematical education as a science but at its best as a discipline of philosophical reflection on the practice and goals of teaching, showing its mettle by providing exciting and surprising points of view not necessarily politically correct. And once again, is that not a worthy cause by itself?

My concern is political; namely, that it otherwise will claim for itself, by virtue not only of its very designation, the ultimate expertise on mathematical education, making itself unassailable to outside criticism.

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The *Notices* invites readers to submit letters and opinion pieces on topics related to mathematics. Electronic submissions are preferred (notices-letters@ams.org); see the masthead for postal mail addresses. Opinion pieces are usually one printed page in length (about 800 words). Letters are normally less than one page long, and shorter letters are preferred.