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How is Mathematics Education Philosophy Reflected in the Math Wars?

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Abstract: Throughout the duration of what has been termed the “math wars”, many overly-generalized statements by both sides have detracted from the quest for a solution to the conflict between conceptual and procedural approaches to mathematics study. In terms of philosophies of mathematics education, the absolutist view posits that mathematical knowledge is certain and unchallengeable while the fallibilist view is that mathematical knowledge is never beyond revision and correction. We suggest that the major mathematics education reforms have been absolutist in focus and have not reflected the changing nature of the discipline. Thus we believe that true reform will reflect changing perceptions in mathematics education along with changes in American culture and its expectations of mathematics education.

Keywords: absolutism; curriculum change; fallibilism; Math wars; Philosophy of mathematics; Philosophy of mathematics education; math reforms

“The math wars are over!” “The National Council of Teachers of Mathematics (NCTM) has come to its senses.” Such catch-cries abounded in response to the NCTM’s publication of *Curriculum Focal Points for Pre-kindergarten through Grade 8 Mathematics* (2006a). This document represents a break with tradition in that it focuses attention on a limited number of significant mathematical goals at each grade level. In the September 12, 2006 press release, NCTM President Francis (Skip) Fennell asserted that “The Curriculum Focal Points present a vision for the design of the next generation of state curriculum standards and state tests” (NCTM, 2006b, para. 3). He sees the focal points as the first step to a national discussion on bringing consistency and coherence to United States mathematics curricula. This document is seen as one response to the “mile wide, inch deep” criticism of United States mathematics instruction, a criticism that most typically arises in the context of comparing the performance of American students with international students on tests of mathematics achievement.

The assertion by some critics that the Focal Points document represents a shift in the NCTM position on basic skills is challenged by Skip Fennell (NCTM, 2006c), who claims that the NCTM has always recognized the importance of building students’ ability to memorize certain basic math facts and procedures. These critics have claimed that the NCTM is doing an about-face. They cite such instances as calculator use replacing mastery of basic skills, that having students describe in writing the reasoning behind their answers meant that students were writing about math instead

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of doing it, and that having students discover their own methods to perform math operations could not lead to mastery (Hechinger, 2006). Another critic, Tamar Lewin (2006, November 14), asserted that planned changes in teaching math in American schools were driven by students' lagging performance on international tests and parents' dissatisfaction with their children's performance in mathematics.

The NCTM's recent involvement in mathematics education reform began with the publication of *An Agenda for Action* (1980) which focused on the need for students to learn how to solve problems. More recently, the following documents have caused substantial public reaction: *Curriculum and Evaluation Standards for School Mathematics* (CESSM) (1989), *Professional Standards for Teaching Mathematics* (1991), *Assessment Standards for School Mathematics* (1995), and the *Principles and Standards for School Mathematics* (PSSM) (2000). Certainly, these documents have focused attention on a standards-based approach to mathematics instruction, described by its critics as "fuzzy math" where individual accountability was replaced by group work, proficiency in basic skills was replaced by reliance on calculators, and serious attention to algorithmic thinking was replaced by "real-life problems." At the time of the publication of PSSM, then NCTM president Glenda Lappan asserted that the original standards (CESSM) (NCTM, 1989) put too much emphasis on new ideas such as teaching conceptual understanding over basic skill development, so that teachers missed the main goal that students become highly skilled in using mathematics (Hoff, 2000). Accordingly, critics of these reform efforts appear to have misrepresented the initiatives of the last two decades.

What tends to be overlooked in these exchanges is how these accusations began. Ever since the First International Evaluation of Achievement (Husen, 1967), we have heard charges of the American mathematics curriculum being a mile wide and an inch deep. Then, as now, one explanation of the relatively poor performance of American students in international tests of comparison was the large number of topics covered at the secondary level, many of them topics that had been introduced previously.

The purpose of this paper is not to join sides in the "Math Wars," or to attribute blame to one side or the other. In a recent commentary, Wallis (2006, November 19) claimed that American education is every bit as polarized, red and blue, as American politics. However, the real issue is not this polarization. Rather, it is to try to understand why different groups within our society have different expectations of a school mathematics curriculum and how they can be explained by differences in philosophy of mathematics education.

Connections between math education philosophy and curriculum change

There is evidence that the two sides of these math wars are not attending to the points made by the other side. McKeown (Hoff, 2000) claimed that the NCTM and its critics agree on "platitudes", but disagree about how much emphasis to put on them. Thus the real issue seems to hinge on different philosophical considerations about the nature of mathematics education. Paul Ernest (1991) describes the two opposing perspectives as "[t]he absolutist view of mathematical knowledge" which "consists of certain and unchallengeable truths" (p. 7), and the "fallibilist view", which "is the view that mathematical truth is fallible and corrigible, and can never be regarded as beyond revision and correction" (p. 18). He maintains that the rejection of the absolutist view "leads to the acceptance of the opposing fallibilist view" (p. 18). Ernest (1994) sees the "central problem of the philosophy of mathematics education" as "the issue of the relationship between philosophies of mathematics and mathematics education" (p. 4).

Although it is generally accepted that Ernest's classification is a dichotomous one, we claim that there exists a continuum of positions between these extremes. To support our claim, we would draw attention to the philosophy implied when observing a math teacher in action. There should be little disagreement when observing a teacher's math lesson that it be categorized as either absolutist or fallibilist. Does that teacher manifest the same implicit philosophy in all lessons he/she teaches? Could it not be that this teacher may demonstrate an absolutist philosophy when teaching math skills, but a fallibilist philosophy when engaging the students in bona fide problem solving? These questions become important when the NCTM is accused of a change of heart. Has the organization (or its leadership) really converted from a fallibilist to an absolutist position?

Most mathematics educators would agree with Fennell's (2006) assertion that the NCTM position has in essence not changed. While the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) made the case that memorization of basic facts and traditional factual tests were being de-emphasized (p. xx), it was not claimed that traditional approaches would disappear. Moreover, articles published in the NCTM journals (*Teaching Children Mathematics*, *Teaching Mathematics in the Middle School*, and *The Mathematics Teacher*) during the past 17 years lean heavily in the direction of student involved approaches. Could we infer from this that such approaches were typical of the mathematics teaching force?

The most succinct answer to this question is provided by an analysis of the *Third International Mathematics and Science Study* (TIMSS) Grade 8 videotapes. We are told (Stigler, Gonzales, Kawanaka, Kroll, & Serrano, 1999; Stigler & Hiebert, 1999) there was uniformity of style among American eighth grade teachers, and the focus clearly indicated an absolutist view of mathematics. How can we explain the evidence that American teachers consistently design lessons grounded in an absolutist perspective despite the existence of a hierarchy of perspectives that includes fallibilism?

Although Ernest (1991) asserts that teachers' strategies in the classroom depend upon their philosophical perspective, he emphasizes the importance of social context. That is, teachers who have different philosophical perspectives may still teach in similar ways and adopt similar classroom practices depending upon the socialization effect of the context. Implementing a fallibilist view in practice, for instance, is far less likely if a teacher's peers and school climate support the absolutist perspective. Teachers may "shift their pedagogical intentions and practices away from their espoused theories" (p. 289) when faced with constraints created by the social context.

Social context, then, is a significant determining factor with respect to educational practice and policy. Educational historian, David Tyack (1974), writes that the central reason for reform failures "has been precisely that they called for a change of philosophy or tactics on the part of the individual school employee rather than systemic change" (p. 10). Although Tyack refers to social injustice and attempted social reform through education policy and practice, the argument can be applied to mathematics reform initiatives. Systemic change may include, in the case of mathematics education, the transformation of the school climate from one emphasizing training for occupation to one enriched with philosophical discourse and the concomitant empowerment of teachers and students to create change. Systemic change, however, has not been typically the focus of recent reform efforts, and that fact may provide a partial explanation for their failures.

History of Mathematics Education Reform

The history of education reform in the twentieth century documents one failure followed by another. Curricular and pedagogical change have been the objects of extensive efforts by authorities in all fields, only to result in very little visible change in the basic curriculum (Kliebard, 1987) or classroom practice (Cuban, 1993). If hundreds of educational reform reports and policy initiatives have had little to no effect with respect to educational changes, then why have policy and reform efforts failed so miserably? Have these policies been poorly designed or designed by individuals and organizations that have little working knowledge of what really goes on in schools? Are schools simply tools of a power elite or dominant class, and curricular and pedagogical reform efforts are designed to maintain the extant power/class structure? Does society need to change before classroom practice will change? Is it possible that teachers' conceptions of mathematics need to undergo significant revision before the teaching of mathematics can be revised? Ultimately, is the problem one of the construction of policy, a socio-cultural context, or philosophically-bound practitioners?

The tension between two almost diametrically-opposed philosophies is visible throughout educational history in the United States. Beginning with the early reform movements that were focused on compulsory education and proceeding through contemporary policy such as the No Child Left Behind Act (NCLB) of 2002, claims about the purpose and means of education have been contentious. The prominent educational philosopher, John Dewey, supported a vision of education as one connected with experience and real-life. Dewey (1936a) argued that mathematics education should be integrated: "Number arises in connection with the measuring of things in constructive activities; hence arithmetic should be so taught and not in connection with figures or the observation of objects" (pp. 213-214). Dewey's critique of the absolutist perspective in mathematics education found expression in his Chicago Laboratory School where mathematics experiences were integrated with other disciplines. His contention was that "Until educators have faced the problem and made an intelligent choice between the contrasting conceptions...I see no great hope for unified progress in the reorganization of studies and methods in the schools" (1936b, p. 396).

Lawrence Cremin (1961) points out that Dewey recognized the importance of learning the basics before proceeding to interpretation and extension. "To recognize opportunities for early mathematical learning, one must know mathematics" (p. 138). According to Cremin, Dewey attempted throughout his life to emphasize the necessity of teachers thoroughly comprehending the disciplines without creating a strictly utilitarian curriculum that accommodated students to existing conditions without enhancing their ability to envision and create change. Cremin writes: "In short, the demand on the teacher is twofold: thorough knowledge of the disciplines and an awareness of those common experiences of childhood that can be utilized to lead children toward the understandings represented by this knowledge" (p. 138).

Visualizing the range of perspectives as an arena rather than as a continuum with absolutist at one end and fallibilist at the other, one might conclude that a melding of the absolutist and fallibilist perspectives, or philosophical movement within the arena of mathematics perspectives, may be essential for authentic learning to occur. The melding of the perspectives, however, has not been visible in the history of American mathematics education. E. L. Thorndike's emphases on recitation and rote memorization followed by measurement of outcomes through achievement testing, advocated in the early years of the twentieth century, have determined the

state of affairs in mathematics education. Students trained in an absolutist philosophy who become teachers will likely teach from the absolutist standpoint.

New Math Reforms

The new math reforms took on different formats in various countries. In the United States and Europe, there was concern that an insufficient number of well-qualified students would be proceeding to post-secondary mathematics. There was a belief among university mathematicians that the secondary school mathematics syllabus needed to be reformed. Accordingly, groups dominated by university mathematicians set out to determine what mathematics should be studied in school to prepare students for university level mathematics. In 1952, the University of Illinois Commission on School Mathematics (UICSM) was formed under the leadership of Max Beberman and its focus was on the structure of mathematical thinking. The School Mathematics Study Group (SMSG) was started in 1958 under the leadership of Edward Begle at Yale (later at Stanford) University. Like UICSM, SMSG was university dominated, and focused on the development of abstract mathematical ideas.

Likewise, in France, Lucienne Felix (1961), a close associate of the Bourbaki group, characterized the revolution there as a response to the need to replenish the supply of potential mathematicians, so many of whom were victims of the war. By contrast, in the United Kingdom, there was considerable involvement by the teaching community in the reforms undertaken. Bryan Thwaites of the University of Southampton headed up the School Mathematics Project where teachers did the writing, and the funding came from industry, not the government. In both settings, the claim was made that there was little change in the mathematics that was to be taught (although that little was quite substantial in the United States and Europe), but that there was to be considerable change in how the mathematics would be taught. However, as Beeby (as cited in Griffiths & Howson, 1974) points out about the role of teachers in curriculum reform, “the average teacher has a very great capacity for going on doing the same thing under a different name” (p. 143).

Not all mathematicians in the United States were supportive of the direction their colleagues had chosen. Morris Kline (1958) deplored the university domination of the reform efforts which he accused of being more interested in training a new generation of mathematicians than in providing mathematics courses for all. In particular, he found the SMSG program to be prematurely abstract and lacking in links to science.

Why did the “new math” fail? One perspective is offered by Amit and Fried (2002):

In considering why a reform is desirable one looks at the needs and nature of mathematics, the needs and values of society, and the relationship between them; in considering who brings a reform about, one discovers that a balanced participation of mathematicians, teachers, politicians, parents, and students is necessary and that all must somehow work together and come to understand their different motivations and ways of thinking. (p. 365)

Logistically, it would appear that the “new math” failed to meet the criteria identified by Amit and Fried. It was a top-down reform, initiated by the mathematical community, without buy-in from teachers or the public. Griffiths and Howson (1974) discuss two approaches to curriculum change, the first being a reorganization of the mathematics itself, which tends to be teacher-centered, discipline-based and authoritarian. The second is described as an open tendency, one

that reflects liberal attitudes in schools and society at large, and tends to be pupil-centered. These approaches closely parallel the absolutist and fallibilist philosophical positions as described by Ernest. Thus we can infer that one cause of failure of the “new math” was that it represented an absolutist philosophy in what was emerging as a fallibilist world.

The “new math” movement in the USA in the early 1960s reflected the point made above by Amit and Fried (2002). Larry Cuban (1993) discusses the constancy in mathematics instruction even after the “new math” or “Post-Sputnik” reform initiatives were supposedly instituted. Cuban contends that if significant change in schooling is to occur, “then organizational conditions, the forms of education that teachers receive, and the occupational cultures within which they work must also change” (p. 290). The “new math” curriculum changes were not accompanied by larger systemic changes, and were thus judged as failures.

Usiskin (see Amit & Fried, 2002) pointed out that the new math movement was judged a failure by a public misled by the results of such examinations as the SAT and NAEP. SAT scores were low in the new math era, but so were verbal scores. There is a more crucial point, however: there is no evidence that the SAT reflected the values and goals of the new math. Again, as Usiskin points out, the new math did nothing to help slower students—nor was this its intent. Thus, on this score, it would have been legitimate to challenge the values and goals of the new math. We contend, and the history of mathematics education reveals, that a reform movement or new policy or practice cannot be evaluated solely in terms of its own criteria. The reform process cannot be isolated from the educational system as a whole.

Recent Reform Endeavors

The above point is also being made by Stigler and Hiebert (1999) when they assert that “Educational reforms in this country often have been driven by an effort to change our performance on quantifiable indicators” (p. 98). For example, a major thrust of the new math reform was changing the textbooks. Thus one might expect, because American teachers typically rely on the textbook, that the teaching would change accordingly. The National Advisory Committee on Mathematical Education found: “Teachers are essentially teaching the same way they were taught in school. Almost none of the concepts, methods, or big ideas of modern mathematics have appeared” (Conference Board of the Mathematical Sciences, 1975, p. 77). One explanation offered by Stigler and Hiebert is: “The widely shared cultural beliefs and expectations that underlie teaching are so fully integrated into teachers’ worldviews that they fail to see them as mutable...teachers fail to see alternatives to what they are doing in the classroom” (p. 100).

Many reports have been written in recent decades attesting to deficiencies in American mathematics education and suggesting reform initiatives to correct the problems. Those reports and the subsequent failure of suggested reforms provide evidence for the necessity for systemic change. The problem in mathematics education gained national attention in 1983 with the federal government issuance of *A Nation at Risk* (ANAR) (National Commission on Excellence in Education (NCEE), 1983). This report situated blame on education for a perceived diminishing economic vitality in the United States. The central concern of the report was that the nation was falling behind other countries in student achievement which led to a decline in the production of automobiles, steel, and tools. Written by a “blue ribbon” commission appointed by the Secretary of Education, T. H. Bell, the report expressed concerns about improving the quality of schools across the nation. It contained general discussions of the “rising tide of mediocrity” and our threatened future if higher standards were not imposed (p. 5). The report contained a great deal

of inflammatory language that stressed the necessity of raising achievement test scores and increasing the amount of homework required of students. It also contained an interpretation of achievement test scores that has since been repudiated by educational researchers (Berliner & Biddle, 1997).

Bell expressed a personal hope that the commission would emphasize the mastery of mathematics along with other subject areas. The central concern of the final report, however, was not mathematics. The report itself was a brief pamphlet that contained vague recommendations but no suggestions for federal funding to help in carrying out the recommendations contained. It was claimed that the NCEE represented a cross section of the American public, and that the concerns expressed were shared by many. Power structure and content analyses, however, demonstrate that the commission members did not represent the majority of Americans and the recommended reforms would serve specific interests and not others (Hadden, 2003). Despite rhetoric to the contrary, it would appear that the objectives of ANAR were not necessarily in line with those of mathematics teachers or classroom teachers in general, parents, or students. The report, which largely represented the concerns of a section of the American power structure that was highly and intricately connected to the federal government, was likely intended to serve other interests while creating a climate of fear about education.

Establishing the climate of fear was one of the successes to which ANAR may lay claim. That report was quickly followed by hundreds of similar reports nationwide issued by corporations, foundations and think tanks, and school districts. All were concerned with issues of technology and achievement in mathematics and science. They seemed to have little effect, however, on mathematics instruction and learning. Indeed, the ultimate results of ANAR and the other reports did not create significant change in mathematics education. Real results, accompanied by additional legislation, did not even become visible until much later when the No Child Left Behind Act (NCLB) was signed into law in 2002. Between ANAR and NCLB, however, other legislation concerning the state of mathematics education appeared. *America 2000 Excellence in Education Act* (1991) and *Goals 2000: Educate America Act* (1993) established more plans to increase student achievement. Evidence for the failure of reform initiatives, however, continued to mount as demonstrated by the recent math wars. Thus if reforms are to be successful, the culture of both education and our society must be changed.

NCTM Standards

The National Council of Teachers of Mathematics has spearheaded the effort to focus attention on a standards-based curriculum. The most pertinent publications manifesting this attention have been the recent NCTM documents identified above. Support for the NCTM *Standards* came not only from the scientific and professional communities, but also from a diverse group of community organizations.

In considering why a reform is desirable one looks at the needs and nature of mathematics, the needs and values of society, and the relationship between them. In considering who brings a reform about, one discovers that a balanced participation of mathematicians, teachers, politicians, parents, and students is necessary and that all must somehow work together and come to understand their different motivations and ways of thinking. Perhaps this explains why the *Standards* documents have been more generally discussed than previous reform efforts. Whereas, by its very nature, the “new math” was a product of the world of mathematicians, the reform efforts sponsored by the NCTM have had a broad-based buy-in: “The content and processes

emphasized in *Principles and Standards* also reflects society's needs for mathematical literacy, past practice in mathematics education, and the values and expectations held by teachers and the general public" (NCTM, 2000, p. xii).

The *Principles and Standards* document begins by outlining a vision which, from a philosophical standpoint, is clearly fallibilist in nature—constructivist learning where the mathematics is substantive and the learning is student-oriented. Not only did that goal fail to materialize, but concerns about the state of mathematics and science education have become even more vocal in recent years. In the Glenn (2001) report, *Before It's too Late*, we are told that we have only a small window before the intellectual damage to our youth cannot be reversed. Other reports such as *Adding It Up* (National Research Council, 2001) also call for an overhaul of instruction, curricula, and testing for elementary and middle school students in the United States.

Nowhere is this problem with mathematics education made clearer than in the results of TIMSS. This study has led to hand-wringing, finger-pointing, and considerable discussion about what can be done to reverse this trend. One potentially rich explanation emerged from the study of the videotaped lessons at the eighth grade level. These results are described in Stigler et al. (1999). Looking specifically at the United States and Japan, we note that their educational contexts are based on very different cultural traditions. Any attempt to improve mathematics teaching in the United States without changing its culture will prove fruitless. The work of Stigler and Hiebert, along with that of Fernandez and Yoshida (2004), has led to considerable interest in Lesson Study in the United States. (An indicator of this interest is the number of workshops conducted at recent meetings of the National Council of Teachers of Mathematics.) Ultimately, the issue is whether a program designed to improve mathematics instruction in Japan can be transplanted to the United States and prove successful. We can transpose that question and ask: Is it possible to change the prevailing educational philosophy in the United States?

Stigler and Hiebert (1999) believe it is possible by working within the existing educational system. These researchers caution, however, that even in the best of circumstances, change will be gradual and incremental. The stage must be set, they believe, by first building a consensus for continuous improvement; second, set clear learning goals for students and align assessments with these goals; and, third, restructure schools as places where teachers can learn (pp. 138-142). It must be emphasized, at this point in the discussion, that Stigler and Hiebert recommend professionalizing teachers and the occupation of teaching and building infrastructure for support of professionalization. These researchers see Lesson Study and professionalization as answers to achievement problems.

Implications of Math Curriculum Reform

One stated purpose of the NCLB legislation was to provide every child (including the disadvantaged) with the opportunity to succeed in mathematics. In fact, the law indicates that there will be consequences for schools if all students do not succeed. We have observed that students are tested annually, that failure to perform adequately on these tests has serious consequences, and that because of these consequences, many teachers are "teaching to the test" and ignoring other educational goals. Considering the influence of the NCLB legislation on the teaching and learning of mathematics in the United States, and given the nature of these reports

and this legislation, it is pertinent to ask whether the conflicting philosophies of mathematics education implied by the absolutist/fallibilist dichotomy are rigid or somewhat pliant.

When Stigler and Hiebert (1999) advocate the use of Lesson Study in United States schools, they are well aware that its implementation cannot be successful unless it is accompanied by ideological and cultural change within schools. We cannot expect this to happen in the short-term. It will take sustained, deliberate, long-term efforts resulting in small incremental changes. It remains to be seen whether this can happen in the USA, or whether the culture is so ingrained that change will not readily occur. If this is the case, what *will* it take to bring about real change in mathematics education in the United States? In the midst of this philosophical debate, it is pertinent to think about the different sides in the discussion and whether we are dealing with “essentially contested concepts” that are so ideologically laden that they do not allow for resolution (Gallie, 1955-1956).

Our concern is that one side's "eternal truths" will be viewed by the other side as "stagnant dogma". Unless the supporters of both perspectives attempt the development of some common ground, the future of mathematics education may lead only to the recycling of time-worn arguments. If this is the case, elementary and secondary students may continue to ask why this or that skill or concept must be learned. The models employed will continue to reduce mathematics to a set of measurable objectives, narrowly defined, tested and then discarded because they are applicable only in rare circumstances.

We are uneasy about the possibility that mathematics may not be seen as a fruitful avenue for solution to real social problems. Perhaps some of our students may continue to believe that as long as one can balance the checkbook and employ third grade addition and subtraction skills, there is no reason to learn algebra. The models employed will remain constraining and confining. They will limit the vision of what is possible. If mathematics is taught as a body of knowledge to be memorized and regurgitated, it may lose its dynamic character and become a set of painful mind games. If educators continue to plan and teach lessons based on the absolutist philosophical position without taking account of history, context, and culture, some students will continue to see mathematics as stagnant rather than dynamic—something to be gotten through. The end becomes the goal, rather than the goal being a joyful journey of learning. If the fallibilist continues to espouse a position that amelioration between philosophical positions is not possible, then perhaps it *will not be* possible.

For all students to see the intrinsic joyfulness and usefulness of mathematics, the subject areas must be integrated with the physical, biological, and social sciences. We must teach our students that the mathematics are and always have been tied up with power and social relations; and, we should encourage our students to study those relations. Students must be allowed the freedom to shape curriculum in ways that are meaningful to them. Studying statistics, for instance, without the vigor of interpretation may cause the field to become theoretically bankrupt. The question of causes and alternative perspectives will enrich that study. Integrated with the study of history and economics, the study of statistics becomes a way to reveal underlying power relations.

Teachers, as well, should be encouraged to develop professionally through philosophical discourse with their peers, to plan and teach together, and engage in peer evaluation that is truly collaborative and non-threatening. It is our concern that mathematics may not be seen by students or teachers as a spirited discipline with a vivacious past and robust future unless and

until it can be seen as interdependent and integrated with other disciplines. On the other hand, there are some concepts that must be learned, that appear to us now as eternal and unchanging. Those must be taught, as well, with the knowledge that at this time and in this place this concept is the one that informs our thinking on this matter. The point is that those "eternal" concepts are readily taught and learned. The real work comes in constructing learning that reflects changing conceptions and the social circumstances in which they occur.

Our society is undergoing continual transformation. The education system, however, tends to be in a reactive mode. The community at large has something of an industrial age expectation of mathematics curricula as evidenced by the absolutist perspective and its emphasis on procedural competence. We seek, instead, an information age perspective based on a combination of absolutist and fallibilist conceptions. We are looking for reforms in mathematics education that reflect the changing nature of American society, but incorporate a vision of cultural change.

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