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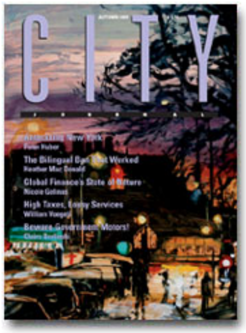

Autumn 2009 vol. 19, no. 4

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A quarterly magazine of urban affairs, published by the Manhattan Institute, edited by Brian C. Anderson.

Eye on the News

SANDRA STOTSKY

Who Needs Mathematicians for Math, Anyway?

The ed schools' pedagogy adds up to trouble.

13 November 2009

The statistics on U.S. math performance are grim. American eighth-graders ranked 25th out of 30 countries in mathematics achievement on the 2006 Programme for International Student Assessment (PISA), which claims to assess application of the mathematical knowledge and skills needed in adult life through problem-solving test items. We do better on the Trends in International Mathematics and Science Study (TIMSS), whose test items are related to the content of school mathematics curricula. (Differences in participating countries aren't significant.) But according to Mark Schneider, a former commissioner of education statistics at the Department of Education, the United States lags behind too many countries in "overall mathematics performance and in the performance of our best students." And achievement gaps between different student groups *within* the United States, Schneider says, are "about the same size or even bigger than the gap between the United States and the top-performing countries in TIMSS."

As part of his education-reform plan, President Obama wants to "make math and science education a top priority" and ensure that children have access to strong math and science curricula "at all grade levels." But the president's worthy aims won't be reached so long as assessment experts, technology salesmen, and math educators—the professors, usually with education degrees, who teach prospective teachers of math from K–12—dominate the development of the content of school curricula and determine the pedagogy used, into which they've brought theories lacking any evidence of success and that emphasize political and social ends, not mastery of mathematics.

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The math educators' rising influence over the last few decades is reflected in the content of, or response to, two influential national reports. In 1989, the National Council of Teachers of Mathematics (NCTM), the chief professional organization for mathematics educators and education faculty, issued *Curriculum and Evaluation Standards for School Mathematics*. The document presented standards for grades K–12, including algebra. The underlying goals of the standards—never made clear to the general public—were social, not academic. Some of the report's authors, for example, sought to make mathematics "accessible" to low-achieving students, yet meant by this not, say, recruiting more talented undergraduates into teaching but instead the employment of trendy, though empirically unsupported, pedagogical and organizational methods that essentially dumb down math content. Math educators proclaimed a brand-new objective—conveniently indefinable and immeasurable—called "deep conceptual understanding."

At first, the NCTM's document drew some public applause for urging K–12 textbook publishers to present math in ways that might better engage student interest. But concerns quickly arose among mathematicians, who found the high school standards inadequate, including their de-emphasis of computation in algebra and proofs in Euclidean geometry. They also noted that none of their academic brethren had participated in the standards' development. Mathematically literate parents, too, were troubled, as they began to see the holes in the wholesale changes being made to state curriculum frameworks, math textbooks, and classroom practices. The ensuing controversy came to be called the "math wars."

To fend off the critics, NCTM issued *Principles and Standards for School Mathematics* in 2000. But this follow-up ignited at least as much censure from mathematicians, scientists, and parents as its predecessor did, even though some mathematicians had participated this time around.

The educational trends that led to the NCTM's approach to math have a long pedigree. During the 1970s and 1980s, educators in reading, English, and history argued that the traditional curriculum needed to be more "engaging" and "relevant" to an increasingly alienated and unmotivated—or so it was claimed—student body. Some influential educators sought to dismiss the traditional curriculum altogether, viewing it as a white, Christian, heterosexual-male product that unjustly valorized rational, abstract, and categorical thinking over the associative, experience-based, and emotion-laden thinking supposedly more congenial to females and certain minorities.

Those trying to overthrow the traditional curriculum found mathematics a hard nut to crack, however, because of the sequential nature of its content through the grades and its relationship to high school chemistry and physics. Nevertheless, education faculty eventually figured out how to reimagine the mathematics curriculum, too, so that it could march under the banner of social justice. As Alan Schoenfeld, the lead author of the high school standards in the 1989 NCTM report, put it, "the traditional curriculum was a vehicle for . . . the perpetuation of privilege." The new approach would change all that.

Two theories lie behind the educators' new approach to math teaching: "cultural-historical activity theory" and "constructivism." According to cultural-historical activity theory, schooling as it exists today reinforces an illegitimate social order. Typical of this mindset is Brian Greer, a mathematics educator at Portland State University, who argues "against the goal of 'algebra for all' on the grounds that . . . most individuals in our society do not need to have studied algebra." According to Greer, the proper approach to teaching math "now questions whether mathematics as a school subject should continue to be dominated by mathematics as an academic discipline or should reflect more fully the range of mathematical activities in which humans engage." The primary role of math teachers, constructivists say in turn, shouldn't be to explain or otherwise try to "transfer" their mathematical knowledge to students; that would be ineffective. Instead, they must help the students construct their own understanding of mathematics and find their *own* math solutions.

Classroom practices follow logically from these theories. Teacher-directed learning goes out the window, despite its demonstrated benefits for students with learning problems; instead, schools should embrace “student-centered” math classrooms. High-math-achievement countries teach arithmetic in the elementary grades in a coherent curriculum leading, step by step, to formal algebra and geometry in middle school. The progressive educators, by contrast, support “integrated” approaches to teaching math—that is, teaching topics from all areas of mathematics every year, regardless of logical sequence and student mastery of each step—and they downplay basic arithmetic skills and practice, encouraging kids to use calculators from kindergarten on. The educators also neglect the teaching of standard algorithms (mathematical procedures commonly taught everywhere, with only minor variations, because of their general applicability), insisting instead on the value of student-developed algorithms—this despite research by cognitive psychologists strongly supporting a curriculum that simultaneously develops conceptual understanding, computational fluency with standard algorithms, and problem-solving skills as the best way to prepare students for algebra.

The heart of the disagreement between progressive math educators and mathematicians is whether students are acquiring a foundation in arithmetic and other aspects of mathematics in the early grades that prepares them for authentic algebra coursework in grades 7, 8, and 9. If not, they then cannot successfully complete the advanced math courses in high school that will prepare them adequately for freshman college courses using mathematics. To address these concerns, the president issued an executive order in 2006 forming the National Mathematics Advisory Panel, of which I was a member. The panel, composed of mathematicians, cognitive psychologists, mathematics educators, and education researchers (my expertise is in reading research, K–12 standards, and teacher education), and appointed by then–secretary of education Margaret Spellings, would examine how best to prepare students for Algebra 1, the gateway course to higher mathematics and advanced science, based on the “best evidence available.” For the panel, educational equity meant not dumbing down content but enabling most U.S. students to travel the same road together to Algebra 1—before ninth grade—just as students do in top-achieving countries. The panel also spelled out the 27 major topics of school algebra that should be taught in every American high school to make us internationally competitive.

The panel found little if any credible evidence supporting the teaching philosophy and practices that math educators have promoted in their ed-school courses and embedded in textbooks for almost two decades. It did find evidence for the effectiveness of a highly structured approach to teaching computational skills, called Team Assisted Individualization; of formative assessment, which entails ongoing monitoring of student learning to inform instruction; of the use of high-quality technology for drilling and practicing; and of explicit systematic instruction for students with learning disabilities and other learning problems. Despite the proven effectiveness of these strategies, many math educators view most of them with disdain—most likely because they entail more traditional, structured teaching.

The mathematics educators’ response to the panel’s report came as no surprise. The *Montana Mathematics Enthusiast*, a journal put out by an NCTM state affiliate, was the first to declare the party line in its July 2008 issue, which featured highly critical essays by five mathematics educators. Issue editor Greer declared in his overview that the panel’s report offered nothing useful, since it had “restricted” itself to scientific research and ignored the “rich reflections” of educators, who, in his judgment, had produced the “deepest work in the field.”

These reflections, which progressive educators call “qualitative” or “practitioner” research, generally consist of educators studying their own classrooms and concluding that, yes, their methods work well. One expert in this self-serving practice is Eric Gutstein, a mathematics educator at the University of Illinois in Chicago and another contributor to the July issue. Gutstein proposed that the panel, as an initiative of the "Bush Administration and US financial/corporate elites," sought to bolster "capital's efforts to shore up the US's weakening economic global position," not to benefit "the majority of the US people—particularly marginalized and excluded students of color and low-income students."

The American Educational Research Association (AERA), the premier research organization in education, brought in heavier cannons to blast the panel's report. Its salvo came in the form of 12 highly critical essays in the December 2008 issue of *Educational Researcher*, a prestigious AERA-sponsored journal. Guest editor Anthony Kelley claimed in his introductory essay that the math educators and education researchers whom he'd invited to comment on the panel's report would "contribute to the current discussion of how methodological approaches are matched to and shaped by questions and objectives." He, too, described the panel's report as based on "a strict and narrow definition of 'scientific evidence' and an almost exclusive endorsement of quantitative methods at the expense of qualitative approaches." Moreover, with a striking lack of professional courtesy, Kelley chose not to invite any of the panel's mathematicians to reply. (In a follow-up communication, Kelley stated that he had sought responses from three nationally known mathematicians, none of them from the panel, but that each, for different reasons, had declined.) None of the 12 essays attempted to explain why the panel's "strict" definitions of scientific evidence revealed no support for progressive pedagogy.

A distinct lack of interest in allowing mathematicians a major voice in determining the content of the high school mathematics curriculum isn't confined to educational research publications or presentations. A new effort is under way to develop national math standards for K–12. The two organizations running the effort—the National Governors Association and the Council of Chief State School Officers, with support from both the Department of Education and the National Education Association—have not yet invited a single mathematical or science society to ensure that the high school mathematics standards and "college-readiness" standards they propose in fact prepare American high school students for the freshman calculus courses that serve as the basis for undergraduate majors in engineering, science, and mathematics (as well as other mathematics-dependent majors and technical/occupational programs). The effort, which is being pushed very quickly, seems determined to do an end run around the country's mathematical and scientific organizations and the panel's recommendations on the major topics for school algebra.

Baseless pedagogical theories mean that the educators' long-term captive audience—K–12 teachers, most drawn from the middle academic tier of our high school population and the bottom third of our undergraduate population—will know even less about authentic mathematics than they do now. Alas, so will their students. And even if a new Congress or Secretary of Education were to support the panel's recommendations, it will be essentially business as usual in the public schools so long as math educators, joined by assessment experts and technology salesmen, continue to shape the curriculum.

A form of mathematics stripped of much of its intellectual content has obvious repercussions for higher education and the American economy. Hung-Hsi Wu, a Berkeley mathematician, expressed the view of many of his peers when he wrote in 1997 that the brand of mathematics purveyed by the NCTM's 1989 report "has the potential to change completely the undergraduate mathematics curriculum and to throttle the normal process of producing a competent corps of scientists, engineers, and mathematicians." And Larry Faulkner, the panel's chair and past president of the University of Texas in Austin, warns that if national policy doesn't ensure the development of a large domestic workforce with first-rate technical skills, we risk "technological surprise to our economic viability and to the foundations of our country's security." If the bleak math statistics in the United States don't change soon, such "surprise" may well be imminent. The math wars, which started in debates about pedagogy, may end in questions about the long-term prospects for

American prosperity.

Sandra Stotsky is a professor of education reform at the University of Arkansas and holds the 21st Century Chair in Teacher Quality.

CONTACT INFO:

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