The Misdirection of Middle School Reform

Is a Child-Centered Approach Incompatible with Achievement in Math and Science?

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As concerns about achievement in mathematics and sciences grow in intensity, middle school advocates are increasingly under siege. Notions of child-centered curricula and allowing students to discover their interests face skeptical scrutiny. But the middle school concept—that of a school based on the transition from childhood to adolescence—can prevail if educators heed their critics and refocus on academics.

Recent research shows that critics of the middle school concept may have strong grounds for their concerns about a lack of focus on standards and achievement. But that same research suggests new directions for reform that are diametrically opposed to the "solutions" advocated by many middle school critics. Contrary to the view of some reformers, middle schools are not likely to raise student achievement by going "back to basics," decentralizing governance, creating charter schools, dispensing vouchers, or tracking students by ability. Instead, real reform will require

- adopting mandatory national standards that apply to every school in the nation and define what children should know and be able to do in math and science at every grade level;
- replacing superficial math and science curriculum with research-based curriculum materials that teach challenging concepts in algebra, geometry, biochemistry, and physics; and
- deepening teachers' backgrounds in their subjects to change the way math and science are taught.

A Growing Body of Critics

Since the early 1990s, middle schools have come under fire. Parents disenchanted with perceived low achievement charge that the middle school's child-centered focus gives scant attention to academic achievement (Beane 1999a, 1999b). In the judgment of an increasingly skeptical public, middle schools diminish academic achievement by practices such as abolishing honor rolls, emphasizing collaboration instead of individual accomplishment, and valuing diversity in learning styles over challenging standards. Bradley (1998) reported in *Education Week* on a coalition of parents in Howard County, Maryland, that pointed to declining test scores and charged that an overemphasis on the social, emotional, and physical needs of adolescents had led to the neglect of academic competencies. In a highly charged climate of confrontation, the parents called for a return to ability grouping, greater emphasis on basic skills, and content regimentation.

Do rigorous curriculum and instructional standards suffer in an environment that emphasizes child development? Data about middle school achievement are mixed. Felner, Jackson, and Kasak (1997) found that students in schools with a middle school concept firmly established over time achieve at higher levels than those in schools in the early stages of implementation or in schools not attempting to implement middle school principles. Findings of improved academic achievement were also noted in studies by Lewis (1993), Barris (1992), and Myers (1988).

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Much of the criticism of the middle school strikes at its organizing principle—that middle grades should be a time for allowing students to grow and discover their own interests. Although that principle is laudable, its unintended consequence may be that students arrive in high school unprepared for the academic demands placed upon them. Called the "muddle in the middle" by Bradley (1998) and a "vast educational wasteland" by others, middle schools expose students to a large number of topics and options. This means that their experiences lack depth, so that students never develop more than a superficial level of understanding (American Association for the Advancement of Science 1993).

Breadth versus Depth

The result of emphasizing breadth rather than depth in later elementary and middle grades math instruction is that most U.S. students do not study algebra until the ninth grade. The rest of the world teaches algebra by the eighth grade and in the middle years begins to introduce challenging concepts in geometry, probability, and statistics. In the United States, most eighth graders are continuing to study arithmetic, even though they are already proficient in arithmetic, because math teachers at that level say that students are "not ready" for algebra.

And they are right. Eighth-grade students in the United States are ill-equipped for algebra because U.S. sixth- and seventh-grade math curriculum programs generally repeat those of grades 4, 5, and 6, thus precluding students from gaining a familiarity with key algebraic concepts in grades 6 and 7. U.S. students are not ready for algebra despite the fact that children in virtually all other countries are ready, not because they are developmentally incapable, but because the curriculum has not prepared them for challenging mathematics.

The Third International Math and Science Study (TIMSS), which in 1995 tested the math and science achievement of more than five hundred thousand students in forty-two nations, revealed as one of its most important findings that curriculum really matters (Schmidt 1999). TIMSS originated at Boston College in response to the need of the American education community for reliable and timely data on the math and science achievement of U.S. students compared to students in the rest of the world. The study tested primarily but not exclusively students from countries with developed economies, including most of Europe, the Russian Federation, the United States, Canada, Japan, Singapore, Hong Kong, Korea, Iran, Australia, New Zealand, and South Africa (see TIMSS Web site, <http://timss.bc.edu>, for complete list). Test items were designed to assess the respondent's ability to apply knowledge in mathematics and science. The study is generally considered the largest, most comprehensive, and most rigorous assessment of its kind.

TIMSS has been criticized for failure to meet its own standards for quality control, failure to take into account differences in age among students in the final year of schooling in various countries, and insufficient reliability. Bracey (1998) denounced it for testing students on subjects they haven't studied. But the proportion of U.S. students enrolling in rigorous math and science classes in their final year of schooling is highly significant. In U.S. schools, most students stop taking math and science after tenth or eleventh grade. As I depict in table 1, this is not the case in the rest of the world (Martin and Kelly 1996).

Policymakers might not care if U.S. students study algebra later than their counterparts elsewhere if they made it up through a rigorous high school mathematics curriculum. But the overwhelming majority of U.S. students begin to learn rigorous mathematics concepts later than their peers and cease their studies in math sooner. Only 1 percent of U.S. high school seniors elect to take Advanced Placement calculus. This phenome-

TABLE 1
Numbers of Students Taking Mathematics in Final Year of Secondary School in Other Nations Compared to the United States

More students taking math than in United States	Same number of students taking math as in United States	Fewer students taking math than in United States
Cyprus	Australia	Canada
Czech Republic	Iceland	
Denmark	Netherlands	
France	New Zealand	
Hungary	Norway	
Italy	South Africa	
Lithuania	Sweden	
Russian Federation	Switzerland	
Slovenia		

non is mirrored in the science curriculum as well. Even among college-bound high school seniors, 51 percent do not take four years of science (Schmidt 1997).

Overall, U.S. students exit high school with less knowledge about math and science than students in other countries tested (Martin and Kelly 1996). U.S. students did not start behind. In fact, they started ahead of other nations, as evidenced by fourth-grade tests: In science, the United States was superior to all but Korea, and they ranked fourth internationally in math. But as they proceed through middle and high school grades, they fall farther and farther behind the rest of the world. By the final year of high school, the test results in math and science of U.S. students are near the bottom compared to those of other nations' students. Reform initiatives that do not address curriculum, instruction, and professional preparedness will have no impact on these results (Schmidt 1997).

Although its findings underscore the paucity of student achievement in U.S. middle schools in both mathematics and sciences (Mullis et al. 1998), TIMSS does not support the directions for change advocated by some critics. Contrary to the belief of those reformers, going "back to basics" is unlikely to raise academic achievement. TIMSS data clearly show that what U.S. students lack is *not* basic math and science. They are already being instructed in the basics—over and over again. Rather, their deficiencies are in higher level mathematics and science concepts. Not understanding such concepts, they are unable to apply them to real-life situations.

The Land(mines)scape of School Reform

Since 1970, more than a thousand school reform laws have been enacted (Gibbs and Fox 1999). Educators and education policymakers are challenged to separate the politically driven from the research driven. Failing to make such distinctions may lead to the conclusion that any reform effort that leaves public education intact is doomed to failure, as Finn (1996) believes:

> The most common approach of the school-reform industry has amounted to piecemeal tinkering with the countless gears and levers of the existing educational machinery: up-grading teacher-training programs, stiffening graduation requirements, installing modern technology, revamping reading programs, shrinking class size, adding a period to the school day. . . . Certainly many such changes are worth making. . . . But piecemeal reform will not fundamentally alter the working of a system in such serious disarray. (43)

Such arguments are offered as justifying vouchers, suggesting that the system is so fatally flawed that it cannot be fixed. Indeed, many so-called reforms have been misguided, misdirected, poorly conceived, and even more poorly implemented. For example, some policymakers have focused on restructuring schools instead of paying attention to the classroom. Restructuring initiatives such as site-based management, charter schools, and voucher systems change the way decisions are made and empower parents but do not necessarily change what happens in the classroom. Rather, unfettered decentralization is counterproductive. It works against the implementation of precisely defined standards on a scale large enough to support and sustain them.

Nor do the TIMSS findings support ability grouping, commonly called "tracking" in U.S. secondary schools. Among developed countries, only the United States and Germany practice tracking. Ability grouping, other than in the most limited circumstances, should not be employed in middle schools because the practice prevents a majority of students from ever taking challenging higher level courses in mathematics and science. Unless middle school students are instructed in algebra, geometry, biochemistry, and physics, they will likely not be prepared for, nor elect to take, rigorous courses in these disciplines at the high school level.

National Standards That Matter and Textbooks That Don't

Unlike nearly all other developed nations, no agreement exists in the United States about what students of a given grade level should know and be able to do in math and science (Schmidt 1997, 1999). U.S. middle schools need true national standards, set by scientists, engineers, and mathematicians rather than politicians or textbook publishers.

Of course, national math and science standards already exist, but they are purely voluntary and each state is free to select or create its own. Misplaced and mythic belief in local control compounds curricular confusion. Most current standards, state or national, avoid specificity by failing to spell out what children should know and be able to do at each grade level. The common practice of aggregating standards for groups of grades lacks precision and confuses accountability. Hirsch (1998) notes that the school year is the basic unit of accountability. Standards must be organized by school year for coherence and consistency.

How those standards are met may be defined by the local unit of government and by skillful teachers, but the standards themselves should not be voluntary. Voluntary standards make no sense unless Americans irrationally believe that the math and science that children need to learn in South Carolina are truly different from the math and science necessary for the children of South Dakota (American Academy for the Advancement of Science 1993; National Academy of Sciences 1996; National Council of Teachers of Mathematics 1991).

Leaving standards to the separate states has resulted in the development of textbooks that try to meet most every state's standards (especially those of large adop-

tion states like California and Texas). Thus, every topic that any state legislature has decided might be of value is crammed into mass-marketed textbooks. TIMSS data reveal that the one area where the United States leads the world is in the size of its textbooks. They are bloated and stuffed with more topics than those of any other country, averaging more than sixty-five topics each. U.S. textbooks often exceed 800 pages in length, whereas textbooks in Japan and Germany more typically run 150–200 pages and address as few as five topics. As a result, U.S. teachers are forced to deal superficially with topics and repeat them again year after year, wasting valuable instructional time.

Project 2061 (American Association for the Advancement of Science 1999) found that every one of the most commonly used commercially developed U.S. science and math textbooks fell short of meeting rigorous standards. Because textbooks include so many topics and because each topic is treated so superficially, students have no opportunity for in-depth understanding and no opportunity for meeting rigorous standards.

Schools should discontinue the use of commercially developed textbook programs that fail to meet rigorous standards and should instead adopt curriculum programs that emphasize hands-on, research-based, inquiry-centered approaches to learning. Middle school math and science education have suffered from a dearth of quality curriculum programs, but two new programs that have survived a thorough research and development process may meet those criteria: "Full Option Science System," developed by the Lawrence Hall of Science, University of California–Berkeley, and "Science and Technology Concepts for Middle School," developed by the National Science Resources Center, Smithsonian Institution/National Academies. These programs, supported by the National Science Foundation, guide students to learn challenging concepts in earth, life, and physical sciences through hands-on, inquiry-centered activities and focused readings that address a smaller number of topics in greater depth.

Professional Development Grounded in Content

Professional development in the United States is too generic. Most professional development is process-based, not grounded in subject matter. Teacher preservice and inservice experiences should focus on teaching content. Teachers need to know more about how to effectively teach the subject areas they are responsible for teaching.

In math, teachers find that many exemplary curriculum programs, including some of those developed with support of the National Science Foundation, are too difficult to teach. This is especially true of teachers who lack a math background. In science, content gets lost in many elementary and middle school classrooms because teachers overemphasize process. When academicians in the United States write standards, they weave together science content knowledge and process skills, both of which are important. Many teachers lack a background in science, but they quickly grasp process. Lacking an understanding of science content, they tend to teach only process components and lose sight of content.

Professional development should be informed by the work of Kaser et al. (1999), among others, and follow National Staff Development Council standards. Its components should include learning content through inquiry, integrating knowledge about math and science with knowledge about learning, developing lifelong learning, and integrating and aligning professional development programming. As advocated by Loucks-Horsley et al. (1998), professional development must be curriculum-centered and standards-based and must focus on moving teachers to become more immersed in content and inquiry-based teaching.

Conclusion

The middle school concept is worth saving. In *Great Transitions* (Carnegie Corporation 1996), a Carnegie Foundation study concluded that substantial and coherent emotional and social support structures are vital to prevent destructive behaviors and promote good health among early adolescents. Middle school practices and support networks that attend to the emotional and social needs of adolescents should not be abandoned in a race to raise test scores.

But such practices and networks should not be the focus of schooling at this level. *This We Believe* (National Middle School Association 1995) focuses excessively on the adolescent; it must be redirected toward what the adolescent ought to know and be able to do. The middle school concept can prevail if educators heed the advice of parents, reformers, and critics and move toward rigorous academic achievement. Middle school education should focus on challenging and rigorous curriculum and instruction aimed at guiding adolescents toward broader and deeper understandings of themselves and the world in which they live.

Key words: middle school reform, child-centered instruction, math and science achievement

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