# The Principals' Partnership

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**A Program of Union Pacific Foundation**

# Research Brief

## Algebra for All

The call for "algebra for all" is not a recent phenomenon. Concerns about the inadequacy of math (and science) preparation in America's high schools have been a steady drumbeat since the 1957 launch of Sputnik; a call for raising standards and the number of math (and science) courses required for graduation has been a part of countless national reports on the status of U.S. education (e.g., *A Nation at Risk*, 1983; The SCANS Report, 1991; Equity 2000; National Commission on the High School Senior Year, 2001; *Breaking Ranks II*, 2004). *No Child Left Behind* can be seen as "a continuation of efforts over the past 40 years by educational policymakers and practitioners to raise standards in mathematics and science" (Shiller & Muller, 2003, p. 300). Fueled by the emergence of a new global economy and the need for twenty-first century knowledge workers, business and political leaders have joined social justice advocates in the call for equal access for all students to a challenging and engaging high school curriculum (though not always for the same reasons).

In 1983, the National Commission on Excellence in Education recommended in *A Nation at Risk* that schools raise the number of credits required for graduation in mathematics (as well as science, English, and social studies.) Most states in the nation followed that recommendation. Recently, after studying the effects of state policies that increased the credit requirements in core content areas, it has become clearer that it is not enough to merely require more math credits for graduation (Teitelbaum, 2003). The emphasis in policy development now appears to be shifting, based on research (e.g., Teitelbaum, 2003) and state test results, to "raising expectations for students' mastery of these subjects, [and] also requiring that all students have exposure to a core curriculum incorporating these standards" (Schiller & Muller, 2003). New policies being adopted by many states now include much more specific direction on which courses students must complete successfully, and/or what the content standards of those courses must include. Such mandates have required school leaders not merely to raise graduation requirements, but also to rethink and often dramatically reform their academic programs in mathematics.

**National Trends**

- By 2008, 39 states either required or were phasing in a requirement that all students complete three years of mathematics in order to graduate, though most states did not specify what the courses or credits must be (ECS, 2008).
- The Education Commission of the States (ECS), the organization that provides education advice to the nation's governors, now suggests "it is most effective to require specific courses, rather than simply requiring more . . . courses," and that, in mathematics, the recommended sequence for all students is Algebra I, Geometry, and Algebra II (Zinth & Dounay, 2007).
- According to a 2007 report from ECS, half the states have adopted a policy requiring at least one credit of Algebra for graduation, with implementation of the policy by at least 2015 (Zinth & Dounay, 2007).
- By 2007, nine states had adopted policies requiring the recommended three course math sequence for graduation (Texas, Arkansas, Oklahoma, South Dakota, Delaware, Indiana, Michigan, Idaho, and Kentucky) with implementation phased in from between 2008 and 2012 (Zinth & Dounay, 2007).
- By 2008, the number of states that had adopted the recommended three course sequence in mathematics had grown to 16 (including Arizona, Minnesota, New Mexico, North Carolina, Ohio, and West Virginia), with implementation phased in through 2015 (ESC, 2008).
- The notion of "algebra for all" is central to several larger, and sometimes differing, reform initiatives including High Schools that Work; Science, Technology, Engineering, Mathematics (STEM) Education; Multiple Pathways (Munson, 1997; Oakes & Saunders, 2008); and Dr. Robert P. Moses'(2001) Algebra Project, a civil rights approach to mathematics reform.

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**Some Arguments and Research Supporting Algebra for All:**

Arguments in support of requiring genuine mathematical literacy for all, including the study of algebra, have been made from both a social justice and an economic perspective.

- "Mathematics has long been recognized as a *critical filter*" for determining who gets access to college and to higher paying careers;" it serves as "a gateway to technological literacy and higher education" (Schoenfeld, 2002, p. 13).

- Unequal access to the academic curricula by poor and minority students, and the disproportionate assignment of poor and minority students to lower track courses that does not include algebra, have been consistently documented (Gamoran & Hannigan, 2000; Schoenfeld, 2002).

- Not only minority students, but also girls have been underrepresented in advanced level math courses (Shiller & Muller, 2003).

- Performance of American students on the TIMSS, in which 40 other countries participated, ranks below the international average (Porter et al., 1998).

- "Understanding basic mathematical principles taught in algebra and geometry are important for students' success in science," and the increasing number of science-related and technical jobs of the future (Shiller & Muller, 2003).

- "'Sixty percent of new jobs will require skills possessed by only 22 percent of the young people entering the job market now." By 2010, "all jobs will require significant technical skills" . . . [and] most jobs of the future "do not yet exist" (Moses, 2001, p. 8 – 9.)

**What Research Suggests About the Impact of Algebra for All**

The assumption that all students—regardless of their gender, race, or class—not only need but are able to master a challenging academic curriculum that prepares them for college or post-secondary training is not new. For example, studies of poor, urban parochial schools that offer only an academic curriculum (e.g., Lee & Burkham, 2003), as well as early "experiments" in high school restructuring around high expectations such as Deborah Meier's (1987) Central Park East in East Harlem have provided evidence that all students have the potential to benefit from access to an academic curriculum. Despite fears that increasing math requirements will penalize poor or minority students, or increase dropout rates, there is evidence to the contrary.

- Course-taking in higher level math (and science) courses "leads to improved student proficiency in these subjects" (Teitelbaum, 2003; Porter, Floden, & Furhman (1998); Shiller & Muller, 2003). "Studies have concluded, almost without exception, that the number of credits earned in math and science is positively associated with student achievement" Teitelbaum, p. 32).

- The assumption that the study of mathematics is so strictly sequential that students who have not mastered "basic skills" cannot possibly benefit from the study of algebra is not borne out by research; "all students, regardless of prior math skills, benefit from taking algebra" although "students at the bottom of the achievement distribution gain less than others" (Gamoran & Hannigan, p. 250).

- When increased course-taking in mathematics was a result of a state mandated graduation requirement and accountability policies, there was a "small but statistically significant effect" on course-taking patterns and on stratification within the courses based on social class, race or ethnicity. "Requiring students to take more academic courses may promote both equity and excellence" (Shiller & Muller, 2003, p. 313).

- "No association" has been found "between increasing high school graduation requirements and student drop out rates;" in fact, during the years immediately following *A Nation at Risk* when states were dramatically increasing graduation requirements, "student persistence in high school increased steadily" (Teitelbaum, p. 32). It should be noted, however,

that "high stakes examinations for students . . . have been related to higher rates of dropping out for at-risk students" and that "greater school accountability" in the form of state mandated testing may increase advanced course taking, but does not lead to higher graduation rates (Shiller & Muller, 2003).

- The National Council of Teachers of Mathematics supports mathematical literacy, including algebra, for all students and believes that all students can learn algebra when it is taught by qualified teachers with the appropriate pedagogical content knowledge. Research on the impact of NCTM standards-based reform on student learning suggests that it "works when it is implemented as part of a coherent systemic effort in which curriculum, assessment, and professional development are aligned. Not only do many more students do well, but the racial performance gap diminishes substantially" (Schoenfeld, 2002, p. 17.)

**A Caution**

The Education Commission of the States (2008) cautions governors that increasing graduation requirements, and requiring that all students have access to challenging mathematics (and science) curricula is only one step in a systemic process for improvement. That process should include:

- Well developed supports and safety nets for students who struggle in mathematics and/or who fall behind in credit acquisition that includes "targeted, high quality remediation";
- Teacher preparation programs that insure the next generation of math teachers have the higher level content knowledge and pedagogical skills required by a more demanding math curriculum;
- High quality professional development specifically in mathematics content and pedagogy for current teachers of mathematics that will insure they are up-to-date and able to teach effectively diverse learners;
- Aligning middle school expectation and curricula with high school expectations and curricula to insure success for all students.

These suggestions may also serve educational leaders at the district level who consider increasing graduation requirements in mathematics for high school graduates.

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