Why invest in improving Algebra 2 and beyond?

Research Note 7

Prepared for Texas Instruments by the Center for Technology in Learning, SRI International,

July 3, 2008

Why invest in improving Algebra 2 and beyond?

Research Note 7

With all the attention given to students' 8th grade test scores, it's easy to forget what matters: whether students continue taking and succeeding in upper level mathematics courses throughout high school and college, not just what they score at one point in time. Indeed, research has consistently and repeatedly shown strong associations between success in more advanced math courses at high school, on one hand, and students' educational attainment, career opportunities and earnings, on the other. The best evidence comes from studies with longitudinal data of nationally representative samples.

By improving Algebra 2 and subsequent high school mathematics courses, schools could broaden the population of students who enroll and succeed in advanced mathematics courses. With each additional mathematics course completed, students become much more likely to graduate from college and to earn a high income as adults.

Obtaining a Bachelor's Degree

The U.S. Department of Education's landmark report (Adelman, 1999) showed that a student's highest level of mathematics courses in high school strongly predicts a student's completion of a bachelor's degree. By tracking a national sample of students who were 10th graders in 1980 for 13 subsequent years, the report showed that finishing a high school course beyond Algebra 2, such as Trigonometry, Pre-Calculus and Calculus, more than doubled the probability of college-enrolled students obtaining their bachelor's degree.

The effect of the highest high school math course was stronger than any other variable examined, including high school test scores, grade-point averages, class rank, track within mathematics courses, socioeconomic status, race, and ethnicity. Similar findings were found in a recent replication study (Adelman, 2006), which used data from the National Educational Longitudinal Study (NELS) that tracked students who were eighth graders in 1988 through the year 2000.

Earning a High Income

Students who took more advanced math courses during high school earned significantly more than those who took only lower level courses (Rose & Betts, 2001, 2004). An additional Algebra or Geometry course is associated with over six percent higher earnings, holding all other typical factors constant. The predicted effect of an additional Calculus courses on earnings is 12 percent.

It is important to note that the studies described above do not claim causality. Furthermore, there are at least two reasons why completing more mathematics courses may increase earnings. First, the mathematics that a student learns in high school may be directly useful to them in college and on the job. Second, upper level mathematics is known to be cognitively demanding, and colleges and employers may select students who succeeded at upper level mathematics because they perceive the students as being smarter (regardless of whether the colleges or employers will require the students to use advanced mathematics).

Indeed, a study indicates that about half of the predicted effect of math courses on earnings comes from cognitive gains directly from the advanced courses in high school, while the other half comes indirectly through enabling students to obtain more postsecondary education (Rose & Betts, 2001, 2004).

What Kinds of Investment are Needed?

Clearly investing in improvements to high school mathematics education could pay handsome returns through the higher degrees obtained by students, the higher incomes they earn, and the greater contributions they make to society. But what kinds of investment are needed?

Recent research using the NELS88 data set provides some answers (Grubb, 2008).
Many effective resources are not simply based on spending levels, but involve integrating several related components. This helps explain why money often does not make a difference to outcomes.

To improve student achievement in Algebra 2, for example, high schools may need to integrate teacher professional development with the purchase of new curriculum materials, as well as give teachers more freedom to innovate. Furthermore, different resources affect different outcomes.

Supportive resources, such as small learning communities, have the most effect on student persistence into higher level mathematics courses (the factor that best predicts college graduation and later earnings).

Cognitive resources, such as an integration of more conceptual, constructivist teaching with traditional skills-oriented teaching, are most likely to boost test scores in a particular course.

Consequently, schools that want to maximize both outcomes – current test scores and success later in life – will invest in both cognitive and supportive resources for their students.

Even for students who do not go on to college, success in mathematics is important. Improving high school mathematics instruction can reduce the high school dropout rate, and simply graduating from high school has an enormous impact on students' earning potential.

Furthermore, for students who do not complete college, math is still important. A study at Cornell University examined a series of military data sets in which worker competencies have been correlated with hands-on measures of job performance (Bishop, 1988). It found that greater competence in higher level math, science, and language arts is indeed associated with greater success in training and better performance on the job.

Ultimately, schools which thoughtfully integrate a mix of resources to comprehensively address the cognitive and support needs of their students through Algebra 2 and beyond will provide the most value to the communities they serve.

References:

Adelman, C. (1999). *Answers in the Toolbox: Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment*. Washington, DC, U.S. Department of Education.

Adelman, C. (2006). *The Toolbox Revisited: Paths to Degree Completion from High School Through College*. Washington, DC, U.S. Department of Education.

Bishop, J. H. (1988). *The Productivity Consequences of What is Learned in High School*. CAHRS Working Paper Series. Ithaca, NY, Cornell University.

Grubb, N. (2008). Multiple resources, multiple outcomes: Testing the "improved" school finance with NELS88. *American Educational Research Journal 45*(1), 104-144.

Rose, H., & Betts, J. R. (2001). *Math Matters: The Links Between High School Curriculum, College Graduation, and Earning*. San Francisco, CA, Public Policy Institute of California.

Rose, H., & Betts, J. R. (2004). The effect of high school courses on earnings. *Review of Economics and Statistics, 86*, 497–513.