ARIZONA STATE UNIVERSITY

EPRU | EDUCATION POLICY RESEARCH UNIT

Colorado
University of Colorado at Boulder

EPIC Education and the Public Interest Center

DOCUMENT REVIEWED:	*The Misplaced Math Student: Lost in Eighth-Grade Algebra*
AUTHOR:	Tom Loveless
PUBLISHER/THINK TANK:	Brown Center on Education Policy at the Brookings Institution
DOCUMENT RELEASE DATE:	September 22, 2008
REVIEW DATE:	October 14, 2008
REVIEWER:	Carol Corbett Burris
E-MAIL ADDRESS:	burriscarol@gmail.com
PHONE NUMBER:	(516) 599-0839

SUGGESTED CITATION:
Burris, Carol C. (2008). *Review of "The Misplaced Math Student: Lost in Eighth-Grade Algebra."* Boulder and Tempe: Education and the Public Interest Center & Education Policy Research Unit. Retrieved [date] from http://epicpolicy.org/thinktank/review-misplaced-math-student

Summary of Review

The Brookings Institution report questions the efficacy of increasing the number of students who take algebra in eighth grade. Although this policy has resulted in more equitable access to advanced math study, the report argues that a subgroup of students enrolled lack the basic mathematical skills needed to succeed. The report further argues that the presence of lower achievers may weaken the instructional opportunities of highly proficient students. The report recommends that algebra placement be based on student readiness, not grade level. Although the report presents a sound case for better mathematical preparation for all students, the suggested remedy—delaying algebra for most until "readiness" is achieved and allowing fewer students to take algebra in eighth grade—is a flawed solution to address the problem of low achievement. A brief overview of the experience with eighth-grade algebra for all in the district where the reviewer works yields findings consistent with the report's call for better math preparation but inconsistent with its call for fewer to take algebra in eighth grade.

Review

I. Introduction

The Brookings Institution report, *The Misplaced Math Student: Lost in Eighth-Grade Algebra*,[1] argues that the growing number of students who now take algebra in the eighth grade has resulted in unintended consequences—specifically the placement of students in a course for which they are insufficiently prepared. The report supports this contention by analyzing the scores of students on the eighth-grade National Assessment of Educational Progress (NAEP) mathematics examination. The report uses data from the 2000, 2005, and 2007 NAEP administrations.

Based on that analysis, the report identifies growth in the percentage of students who are taking algebra in eighth grade and whose NAEP scores are in the lowest 10%. While acknowledging the importance of the study of algebra, the report argues that these students are unprepared and that the course should be reserved for those eighth graders who have achieved the prerequisite skills. It further argues that the presence of students who are lower achievers has a deleterious effect on the learning of advanced students.

The Misplaced Math Student: Lost in Eighth-Grade Algebra also identifies the demographic and other characteristics of students who are asserted to be misplaced in the eighth-grade algebra course. They are more likely to be poor, to be African-American or Latino, to attend urban schools and to have relatively inexperienced teachers. The report asserts that their skills are at approximately the second-grade level.

The report states that a more realistic algebra policy would be based on the assessment of learning rather than course completion. It further recommends, as an important component of reform, early intervention and remediation of arithmetic skills at the elementary level. Finally it suggests that a research base derived from randomized experimentation should guide algebra policy decisions.

The report falls short, however, in identifying the problem that should be addressed. American policy makers know from past experience that the problem does not lie in the goal of all students studying algebra prior to ninth grade. After all, the failure to pursue high math expectations led to the disappointing results that the current reform is attempting to address.[2] The problem, therefore, concerns the adequate preparation of all students to succeed at the eighth-grade algebra goal.

This review will critique the report's use of NAEP data to draw its conclusions, summarize the literature that explains why the goal of algebra for eighth graders is important, and present a brief overview of a research study of a successful program in which all students, including low achievers, take algebra in eighth grade.

II. Findings and Conclusions of the Report

The report's summary conclusion is that the goal of having all students take an algebra course in eighth grade is an educationally unsound policy. Students, the report concludes, would be better served if the goal were that more of them learn algebra, with less attention paid to when they learn it. The report concludes that more than 100,000 students who do not have the prerequisite

skills in arithmetic needed to succeed are misplaced in eighth-grade algebra courses. According to the report, this is unfair to the students who are misplaced as well as to the students who are well-prepared to be in the class.

The report also includes four subordinate recommendations:

- The focus of policy should be on the objective measurement of learning rather than the completion of a course.
- Prerequisite arithmetic skills should be assessed and taught before a student is taught algebra.
- Early intervention should be provided when those skills are found to be lacking. Such intervention should include student accountability measures, such as a summer school requirement.
- Randomized experiments, designed to measure the effectiveness of courses and remediation, should be carried out in order to guide policy.

III. The Report's Rationale for its Findings and Conclusions

The report's rationales for its findings and conclusions are based on the examination of data from the eighth-grade NAEP exam in mathematics. The report uses data from the 2000, 2005 and 2007 exams to make its case. Using 2007 NAEP scores, the report offers a state-by-state comparison, concluding that there is no relationship between the percentage of students taking algebra in eighth grade and that state's scores on the NAEP. The report argues that there should be a pattern of higher scores in states where a higher proportion of students take advanced math in eighth grade. Because no correlation exists, the report reasons that there is no benefit to the policy.

In order to further its conclusion that the increase in the proportion of students taking advanced courses is driven by misguided policy, the report compares 2000 NAEP data with 2007 NAEP data. The report notes that, as the proportion of students taking algebra in eighth grade has greatly increased, there has been a slight decrease (4 points) in the mean NAEP scores of students in advanced math classes. This has occurred even as the overall (national) mean on the eighth-grade NAEP for all students has increased.

Finally, the report makes its case that students are being misplaced by noting that the proportion of lower-achieving students in the course has increased from 8% to 28%. The report defines lower achievers, which it refers to as misplaced students, as students whose scores are in the bottom 10% on the eighth-grade NAEP. It then provides examples of NAEP questions of basic arithmetic to illustrate questions that lower achievers did not correctly answer.

IV. The Report's Use of Research Literature

The report's use of the research literature is limited. The majority of references are policy papers or opinion pieces. The report provides one reference to a book on teaching mathematics,[3] and a reference to only one article from a peer-reviewed journal.[4]

The policy papers referenced are some of the papers that argued for the early study of algebra. The report does not include, however, a review of the key empirical studies that prompted the call for algebra for all students in eighth grade. Such studies include:

- Studies[5] concluding that taking algebra in eighth grade is associated with the

study of advanced mathematics, even when controlling for prior math achievement as well as demographic factors.

- A longitudinal study[6] that found a strong positive relationship between the study of advanced mathematics in high school and later college completion.
- Studies[7] that provide evidence that students with the lowest achievement levels benefit more from studying an accelerated curriculum designed for more proficient students than from a remedial curriculum.

To support the contention that when low achievers are in the classroom with higher achievers, higher achievers suffer, the report references an opinion piece[8] by William Sanders in which he writes that ineffective teaching that gears instruction only to the lowest achievers in the class harms higher achieving students. He explains that the most effective teachers are proficient at teaching students who are at a variety of levels in the same classroom. The original purpose of the article is to argue in support of the value-added model for the measurement of educational progress and teacher evaluation; it has no connection with the conclusions of the Brookings report. In fact, one could take away the message from this opinion piece that better teacher training, induction, and professional development should be called for as a solution to this problem, rather than denying low-achieving students spots in algebra classes.

Finally, the report references an article from a peer-reviewed journal that concludes that students who take algebra earlier have better math skills.[9] The report critiques the article's findings on the basis of selection effects.

In summary, the review of the literature in this report is limited and would be strengthened if it included more peer-reviewed studies that are relevant to the topic.

V. Review of the Report's Methods

The report's methodology is based on the examination of NAEP data. The report acknowledges that these "data cannot prove or disprove causality" (page 4) in regard to the effects of more students taking algebra. The report also acknowledges that it is possible that students may have described their coursework as advanced when, in fact, it was not. The unreliability of student self reports in course-taking has been documented in prior research.[10]

The report uses a standard correlation coefficient to explore the relationship between eighth-grade NAEP scores and the proportion of students who are taking advanced mathematics in eighth grade. In addition, basic descriptive statistics are used to provide a narrative regarding the overall change in scores for students taking advanced mathematics classes and to describe shifts in the proportion of lower and higher achievers in advanced mathematics classes. Finally, the report describes the demographic characteristics of students who are lower achievers in advanced math classes.

The methodology of the report is limited in scope. It cannot be used to draw conclusions regarding whether students' achievement on the NAEP exam in mathematics is affected by the study of algebra in the eighth grade. Because there is no measure of prior achievement, it is impossible to determine whether students who are lower achievers are better served in basic mathematics or algebra, or if wider exposure to eighth-grade course content had any effect on NAEP student scores.

VI. REVIEW OF THE VALIDITY OF THE FINDINGS AND CONCLUSIONS

The report sends two conflicting messages in regard to the validity of its findings. It reminds the reader that one cannot attribute a causal relationship between changes in the percentage of students taking algebra and NAEP scores. This caution is warranted. However, the report then proceeds to use the data to create relationships that do not meet the test of validity, thus weakening the overall credibility of the report's findings and conclusions.

For example, one question posed by the report is whether mandating algebra for eighth-graders will result in students learning more mathematics. To answer this question, the report simply explores whether there is a correlation between the percentage of students taking algebra in each state and state scores. No relationship was found. However, does that mean that the question posed by the report was answered in the negative?

Even if a correlation were found, a valid finding would require that there be an established connection between achievement on the eighth-grade NAEP exam and mastery of an algebra curriculum. This begs the question—what does NAEP measure? Commenting on the NAEP in mathematics, the author of the Brookings report stated in a 2004 interview[11] that 91% of eighth-grade NAEP items are arithmetical skills taught prior to sixth grade, which he considered to be "trivial mathematics." A course in algebra, in which students extensively use the calculator, would not logically be expected to improve a student's skills in such arithmetic computations. Since the outcome measure used in the report—the 8th grade NAEP exam—is relatively unable to pick up improvements in algebra skills (according to the 2004 interview), why would the report use that exam to conclude that students are not learning those skills?

To regard the lack of a positive correlation as a compelling argument against algebra in eighth grade is as speculative as the reverse—attributing higher scores overall to more students taking algebra. Neither claim can be supported.

The report also concludes that well-prepared students in advanced math classes learn less due to the presence of lower achievers in the class. Although the overall score for advanced classes decreased by four points, there is no evidence that scores decreased for the most highly proficient students in algebra. The drop in the mean is more likely attributed to the fact that enrollment in eighth-grade algebra by lower-achieving students has increased from 8% in 2000 to 28.6% in 2005, according to the report.

Lastly, the conclusion that struggling students are better served in basic math classes in eighth grade, and that algebra should be delayed until arithmetic skills are mastered, is not supported by the report's analyses. The report did not provide an analysis or description of student scores in basic math classes. Without data on prior student achievement, there is no means of comparing the effects of the two placements on student learning. This is acknowledged by the report in its call for experimental studies. As noted earlier, however, there already exist peer-reviewed studies that indicate that lower achievers in mathematics learn more when they are in challenging classes with higher-achieving peers. None of these studies were noted in the report.

VII. USEFULNESS OF THE REPORT FOR GUIDANCE OF POLICY AND PRACTICE

Part of this report uses NAEP math scores along with demographic data to highlight the weak mathematical foundation of many of our nation's children. As the report points out, there are many contributing factors associated with low NAEP scores, such as poverty and inexperienced teachers. These problems will not be solved, however, by undermining the goal of algebra for eighth graders, but rather by focusing on how to best prepare all students to succeed at that goal. The focus should be on how we improve learning in grades K-7.

As noted earlier in this review, neither the report's literature review nor its analysis of data lead inevitably or even approximately to the specific conclusions drawn by the report. Alternative interpretations of the data, as well as alternative conclusions, exist but are not discussed. In addition, the reader received no information on the vast majority of students' performance on the NAEP—those who are not in eighth-grade algebra. Thus, while the report implies that students in eighth-grade algebra are worse off than they would have been had they been assigned to less challenging classes, no evidence is provided that supports that conclusion. In fact, there is research that indicates the reverse is true. According to a 2003 report by the National Research Council, students with weak basic skills can be challenged by engaging analysis, and algebra can be successfully introduced prior to the mastery of the basics.[12]

Is it possible that all students, including low achievers, might learn more mathematics when they take algebra in eighth grade? This reviewer was a co-author of a longitudinal study that examined this very question. The studied program of universal mathematics acceleration began in the district where I serve as high school principal. I did not establish the program, but I was part of a research team that documented its efficacy.

Our longitudinal study[13] examined the effects of providing an accelerated mathematics curriculum in heterogeneously grouped middle-school classes in a diverse suburban school district. Specifically, all students took an algebra course that culminated in a New York State exam in eighth grade. Cohorts in which all students took algebra in eighth grade were compared with cohorts prior to the policy of universal math acceleration. The study showed that the probability of successfully completing advanced math courses increased significantly for all student groups in the accelerated cohorts, including minority students, students of low socioeconomic status, and students at all initial achievement levels—low and high.

Other findings from this study similarly call into question the conclusions of the Brookings report, including:

- The overall passing rate for the Sequential I Regents, (a New York State exam that tests knowledge of algebra) was higher for the cohorts in which all students took algebra in eighth grade.
- There was no statistical change in the performance of initial high achievers after more low achievers began taking algebra in eighth grade. In addition, high achievers took significantly more advanced classes following the policy of algebra for all in eighth grade.
- Under the policy, more African American, Latino, and low-SES students passed the exam in eighth-grade algebra classes than when they were tracked and took the class later in high school. Fur-

ther, the district saw a substantial increase in the percentage of minority and low-SES students who went on to take classes at the level of trigonometry and beyond.

In conclusion, the Brookings report appropriately identifies the need for more research in this area, and its subordinate recommendations are strategies that would strengthen any course of studies in mathematics. However, the final conclusion of the report—that the goal of algebra for all in eighth grade is ill-advised—is not substantiated by the data presented. Rather than debating the desirability of placing students in more demanding courses, the true issue to be addressed is the inadequate math preparation of our most vulnerable students that makes success in algebra more difficult.

Notes and References

[1] Loveless, Tom. (2008). The Misplaced Math Student: Lost in Eighth-Grade Algebra. Washington, DC: The Brookings Institute. Retrieved September, 2008 from http://www.brookings.edu/reports/2008/0922_education_loveless.aspx

[2] See Cogan, L. S., Schmidt, W. H. & Wiley, D. E. (2001). Who takes what math and in which track? Using TIMSS to characterize U.S. students' eighth-grade mathematics learning opportunities. *Educational Evaluation and Policy Analysis, 23*, 323-341

Kifer, E. (1993). Opportunities, talents and participation. In L. Burstein (Ed.). The IEA study of mathematics III: student growth and classroom processes. (pp.279-308). Oxford: Pergamon Press

Schmidt, W. H., Mc Knight, C. C., Cogan, L. S, Jakwerth, P.M. & Houang, R.T. (1999). Facing the consequences: Using TIMSS for a closer look at U. S. mathematics and science education. Drodrecht, The Netherlands: Kluwer Academic Publishers

[3] Murnane, R. J. & Levy. F. (1996). Teaching the New Math Basic Skills. New York: The Free Press.

[4] Smith, J. B. (1996). Does an extra year make any difference? The impact of early gains on long-term gains in mathematics attainment. *Educational Evaluation and Policy Analysis* 18 (2), 141-53.

[5] Studies include: Atanda, R. (1999). Do gatekeeper courses expand education options? (National Center for Educational Statistics, NCES 1999303). Washington, DC: U.S. Department of Education.; Horn, L., & Nunez, A.-M. (2000).

Mapping the road to college: First-generation students' math track, planning strategies and context of support (NCES 2000-153). Washington, DC: U.S. Department of Education. Retrieved from http://nces.ed.gov/pubs2000/2000153.pdf.

Stevenson, D. L., Schiller, K. S., & Schneider, B. (1994). Sequences of opportunities for learning. *Sociology of Education, 67,* 184-198.

[6] Adelman, C. (1999). *Answers in the tool box: Academic intensity, attendance patterns and bachelor's degree attainment.* Washington, DC: U.S. Department of Education, Office of Educational Research. Retrieved from http://www.ed.gov/pubs/Toolbox .

[7] Studies include: Burris, C. C., Heubert, J., & Levin, H. (2006). Accelerating mathematics achievement using heterogeneous grouping. *American Educational Research Journal 43* (1), 103-134.

Peterson, J. M. (1989). Remediation is no remedy. *Educational Leadership, 46*(6), 24-25.

White, P., Gamoran, A., Porter, A. C., & Smithson, J. (1996). Upgrading the high school math curriculum: Math course-taking patterns in seven high schools in California and New York. *Educational Evaluation and Policy Analysis, 18,* 285-307.

[8] Sanders, W. (1999). Teachers, teachers, teachers. *Blueprint Magazine*. Retrieved September, 2008 from http://www.dlc.org/ndol_ci.cfm?contentid=1199&kaid=110&subid=135.

[9] Smith, J. B. (1996). Does an extra year make any difference? The impact of early algebra on long-term gains in mathematics. *Educational Evaluation and Policy 18* (2), 141-53.

[10] Lucas, S. R., & Gamoran, A. (1993). *Race and track assignment: A reconsideration with course-based indicators of track location.* Washington, DC: Office of Educational Research and Improvement; Rosenbaum, J. E. (1980).

Rosenbaum, J.E. (1980). Track misperception and frustrated college plans: An analysis of the effects of track and track perceptions in the national longitudinal study. *Sociology of Education, 53,* 74-88.

[11] Toppo, G. (2004). Study says students' math proficiency doesn't add up. *USA Today*. Retrieved October, 2008 from http://www.usatoday.com/news/education/2004-11-17-students-math_x.htm.

[12] National Research Council and the Institute of Medicine. (2004). *Engaging schools: Fostering high school students' motivation to learn.* Washington, D.C.: National Academy Press.

[13] Burris, C. C., Heubert, J., & Levin, H. (2006). Accelerating mathematics achievement using heterogeneous grouping. *American Educational Research Journal, 43* (1), 103-134.

The Think Tank Review Project is made possible by funding from the Great Lakes Center for Education Research and Practice.