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Title: Using assessment data to guide math course placement of California middle school students

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Abstract

Background / Context:
Middle school math placement and progression are topics that are part of an active policy and practice discussion in California and elsewhere. Beginning in the 2008/09 school year, California's State Board of Education recommended that students complete algebra I by the end of grade 8. Between 2003 and 2009 the proportion of grade 8 students taking algebra I rose from 32 percent to 54 percent (Williams et al., 2011). This increase resulted in a larger percent-age of grade 8 students scoring "proficient" or "advanced" (achieving proficiency) on the algebra I California Standards Test (CST; see box 1 for definitions of key terms used in this report) and in a larger number of grade 8 students scoring "far below basic" or "below basic" on the test (Williams et al., 2011)

Recent studies show that enrolling in algebra I in grade 8 works well for some students but backfires for others. The consequences of misplacement are most pronounced for students with weaknesses in key foundational areas that support algebra readiness, which frequently translates into difficulty reaching proficiency in higher level math in high school (Finkelstein et al., 2012). One study of California students concludes that placing all grade 8 students in algebra I, regardless of their preparation, sets up many students to fail (Williams et al., 2011). Recent longitudinal analysis of California statewide assessment data suggests that students who do not take algebra I in grade 8 but are successful in general math have a better chance of succeeding in algebra I when they wait until grade 9 (Liang, Heckman, & Abedi, 2012).

Purpose / Objective / Research Question / Focus of Study:
Are there effective ways to identify which students will be most likely to succeed (achieve proficiency) in algebra I in grade 8? To answer this question, research team, in collaboration with eight school districts in Silicon Valley, CA, estimated the relationships between two assessments available to the SVRA districts and students' likelihood of achieving proficiency in algebra I. These estimates were then used to determine how well different assessments identified students who were more likely to achieve proficiency in algebra I in grade 8.

This study addressed two broad research questions:

1. What is the relationship between proficiency on the algebra I CST in grade 8 and scores on the grade 6 math CST, the grade 7 MDTP test, and the grade 7 math CST?
2. How can test scores better assist with initial placement decisions?

Setting:
The study involved 8 districts in Silicon Valley, Ca. They are Alum Rock K–8 School District, Berryessa Union Elementary School District, Franklin-McKinley Elementary School District, Milpitas Unified School District, Mt. Pleasant Elementary School District, Oak Grove School District, San Jose Unified School District, and Sunnyvale School District. The first five school districts are among seven feeder school districts to East Side Union High School District.

Population / Participants / Subjects:
The analytic sample for this study consisted of the students enrolled in algebra I in grade 8 in Silicon Valley Research Alliance (SVRA) districts in the 2011/12 school year and for whom

scores were available for all four of the tests of interest: grade 7 Mathematics Diagnostic Testing Project (MDTP), grades 6 and 7 math California Standards Tests (CSTs), and algebra I CST. Students who were enrolled in an individualized education program (141 students) were omitted from the sample because these students may receive a modified curriculum. The analytic sample consisted of 2,579 students (See Table B1).

Intervention / Program / Practice:
The study focused on grade 8 Algebra I placement decisions, and the manner in which assessment data could inform and improve those decisions. At the time of the study, the participating SVRA districts had agreed to place students in algebra I based on the strategies presented in a 2010 memorandum of understanding that supported the use of multiple criteria (including course performance, teacher recommendations, diagnostic tests, and CST performance). The memo indicated that students who achieve proficiency on the grade 6 or grade 7 math CST should be placed in algebra I in grade 8. However, grade 7 CST data were not typically available in time for initial placement decisions. As a result, many districts were using grade 6 CST proficiency status as the primary determinant for grade 8 Algebra I placement.

This process was complicated by the availability of results from new diagnostic assessments of grade 7 students' math performance (and perhaps algebra readiness) before grade 7 math CST results are available. In the past, the SVRA districts relied on students' prior math CST scores in making algebra I placement decisions. In 2010 some SVRA districts began to use the tests developed under the Mathematics Diagnostic Testing Project (MDTP), to assist with these decisions. Three types of MDTP results are available: the number of MDTP topics mastered, the level of mastery of each topic, and the topic scores. The MDTP tests can be administered online, and the results are available immediately after completion. CST results, by contrast, are not available until August, and in some years are not available until after the next school year begins. Therefore, some districts were exploring the use of MDTP results to assist with initial placement decisions.

Research Design:
Exactly which combination of tests would ensure the highest number of accurate placements remained unclear. The SVRA districts were interested in knowing whether and how to incorporate these different assessments into their math placement decisions in grade 8 and how different approaches would affect their students' algebra I proficiency rates in grade 8. To address the districts' interests, this study focused on the relationships between students' performance on these different assessments and their proficiency on the algebra I CST.

The study used grade 6 and 7 math CST scores, grade 7 MDTP test scores, and algebra I CST scores for students enrolled in algebra I in grade 8 in the 2011/12 school year in SVRA districts. The study used cross-tabulation and logistic regression analyses to study the association between students' performance on the grade 8 algebra I CST and their prior performance on the grade 6 math CST, grade 7 MDTP test, and grade 7 math CST. In particular, the analysis examined how algebra I proficiency rates in grade 8 varied with grade 6 math CST scores.

Next, the percentage of students achieving proficiency on the algebra I CST in grade 8 was calculated for each grade 6 math CST scale score to identify the grade 6 math CST scale score

associated with students having at least a 50 percent probability of achieving proficiency on the algebra I CST in grade 8. The predictive accuracy of this cutpoint score was then compared with that of the CST cutpoint for proficiency status. Logistic regression was used to compare the accuracy of predictions based on different scores, including grade 6 math CST scale scores, grade 7 MDTP scores, and grade 7 math CST scale scores. These results were used to examine the implications of algebra I placement decisions in grade 8 made using different sources of information.

Data Collection and Analysis:
The study used grade 6 and 7 math CST scores, grade 7 MDTP test scores, and algebra I CST scores for students enrolled in algebra I in grade 8 in the 2011/12 school year in the participating districts (2,579 students from five districts; see table B1 in appendix B). The study used cross-tabulation and logistic regression analyses to study the association between students' scores on the algebra I CST in grade 8 and their prior performance on the grade 6 math CST, grade 7 MDTP test, and grade 7 math CST. In particular, the analysis examined how algebra I proficiency rates in grade 8 varied with grade 6 math CST performance.

The logistic regression model took the following form: $\Pr(\text{Proficiency} = 1) = \text{logit}^{-1}(\beta 0 + \beta 1 CST_{ij} + \zeta 0_j + \varepsilon_{ij})$, where CST_{ij} is the grade 6 math CST scale score of student i in school district j. $\beta 0$ and $\beta 1$ are parameters estimated from the data presented as odds ratios, which identify how the odds of achieving proficiency on the algebra I CST in grade 8 change with a one-unit change in the independent variable. For example, $\beta 1$ indicates how the odds of achieving proficiency on the algebra I CST in grade 8 vary with a one-unit change in the grade 6 math CST scale score. $\zeta 0_j$ is a district random effect, where $\zeta 1_j \sim N(0, \upsilon 1)$, and ε_{ij} represents the residual error term where $\varepsilon_{ijk} \sim N(0, \theta)$. These models were adapted for use with other independent variables, including MDTP scores, MDTP topic mastery indicators, and grade 7 math CST scale scores.

Findings / Results:
Using students' grade 6 math CST scale score rather than proficiency status increases the accuracy of algebra I placement decisions in grade 8 from 69 percent to 75 percent. Moving beyond the simple zero or one indicator of proficiency status (achieving proficiency or not), the study used continuous grade 6 math CST scale scores and a logistic regression to predict student probability of achieving proficiency on the algebra I CST in grade 8.Students who had a predicted probability of 50 percent or higher were considered algebra ready. Compared with decisions based on proficiency alone, this approach increased the accuracy of algebra I placement decisions in grade 8 by 6 percentage points, suggesting that it is a more accurate way to predict proficiency on the algebra I CST in grade 8.

To have more than a 50 percent chance of achieving proficiency on the algebra I CST in grade 8, students need to score at least 17 points above the proficiency cutpoint on the grade 6 math CST. Simply scoring at the proficient level (a scale score of 350) is not enough to give a student a greater than 50 percent chance of achieving proficiency on the algebra I CST in grade 8. Students who scored 350 had only a 39 percent probability of achieving proficiency. Raising the probability to 50 percent required a scale score of 367 or higher on the grade 6 math CST (0.27 standard deviation above the proficiency threshold).

As long as scale scores were used, prediction accuracy did not vary substantially based on the assessment. To assess the potential contribution of the MDTP test to accurate placement decisions, several combinations of grade 6 and 7 assessments were used to predict algebra I proficiency in grade 8. Models using the grade 6 CST scale scores alone, the grade 7 CST scale scores alone, the grade 7 MDTP, or CST scale scores in combination with the MDTP scores all resulted in accurate predictions of success between 75 and 78 percent of the time.

MDTP scores in five of the seven topics are significant predictors of algebra I proficiency. Scores on five of the seven MDTP topics are significant predictors of students' odds of achieving proficiency on the algebra I CST in grade 8, even after controlling for grade 6 CST scale score (table 6). For example, holding other predictor scores constant, a one percent-age point increase on MDTP topic area 6, integers, is associated with a 26 percent increase in the odds of achieving proficiency on the algebra I CST in grade 8.

Using grade 7 math CST scores to fine-tune placement decisions before the beginning of grade 8 does not necessarily result in more accurate placement outcomes. Schools and districts often revisit spring placement decisions once grade 7 math CST scores are available, generally around August. The vast majority of students (over 80 percent) who were predicted to succeed in Algebra I based on one assessment were also predicted to succeed based on others. Moreover, the probability of grade 8 success for students with different predictions based on different tests was only about 50 percent.

Conclusions:

The findings of this study have several implications for policy and practice related to accurately identifying students who are likely to achieve proficiency in algebra I in grade 8. By itself, proficiency on the grade 6 math CST is not an effective indicator of algebra readiness: Most students who score at the proficient level (a score of 350) do not achieve proficiency on the algebra I CST in grade 8. Students have to score at least 0.27 standard deviation above the proficiency cutpoint to have even a 50 percent probability of achieving proficiency. This suggests that the accuracy of placement decisions could be improved by moving beyond proficiency on the CST and relying instead on scale scores to identify students who have at least a 50 percent chance of succeeding in algebra I.

The findings also suggest that MDTP scores are an effective tool for predicting grade 8 algebra success, and that moving students with disparate assessments into grade 8 Algebra I is unlikely to increase student success rates. This suggests that immediately available, easily administered assessments such as MDTP scores are potentially effective tools for making placement decisions.

Appendices

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Appendix A. References

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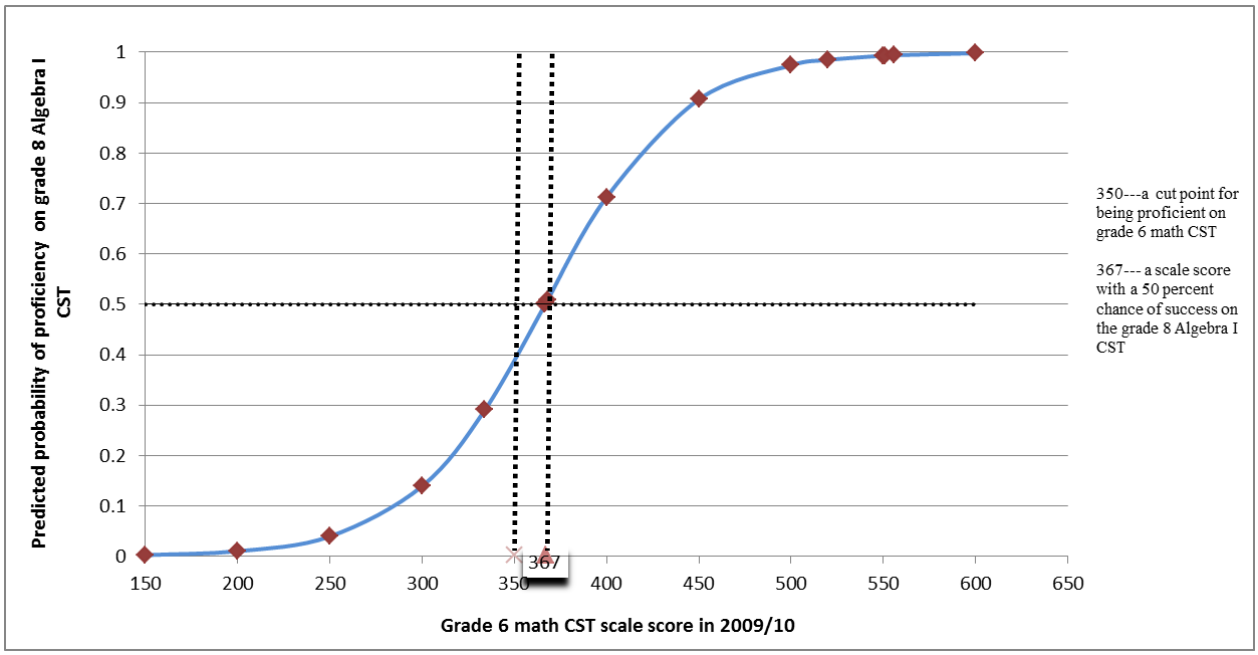
Appendix B. Tables and Figures

Table B1. Study sample

District	Number enrolled[a] in grade 8 (2011/12)	Number of students with all four test scores	Number of IEP students	Number of students in final analytic sample	Final analytic sample as percentage[b]
Alum Rock	1,273	522	9	513	40%
Berryessa	933	370	16	354	38%
Franklin-McKinley	956	286	9	277	29%
Milpitas	738	0	0	0	0%
Mt. Pleasant	291	0	0	2	0%
Oak Grove	1,263	572	25	547	43%
San Jose	2,394	970	82	888	37%
Sunnyvale	593	0	0	0	0%
Total	8,441	2,720	141	2,579	31%

Notes:
a. Information was retrieved from http://www.ed-data.k12.ca.us on May 20, 2013.
b. Percentage was computed based on enrollment data.
Source: Authors' analysis of primary data collected for the study.

Figure B1. Students who scored at the *proficient* level on grade 6 math CST had less than a 40 percent chance of success on the grade 8 Algebra I CST



Source: Authors' analysis of primary data collected for the study.

Table B2. The accuracy of prediction with respect to grade 8 Algebra I CST proficiency ranges from 75 to 78 percent, depending on which assessments are used

Model	Predictor(s)	Accuracy
1	Grade 6 math CST scale scores	75
2	Grade 7 MDTP (7 indicators)	77
3	Grade 7 MDTP (7 topic-area scores)	76
4	Grade 6 math CST scale scores, Grade 7 MDTP (7 topic-area scores)	77
5	Grade 7 math CST scale scores	78

Note: A probability cutoff of 0.5 was used as it typically yields the highest percentage of students being correctly classified (table B2 in appendix B). The accuracy based on other probability cutoffs is reported in table B3 of appendix B.
Source: Authors' analysis of primary data collected for the study.