The Missing Link in Accelerated Algebra Policy Analysis: a Case Study of Recommendation and Placement in 8th Grade Algebra

Descriptors

Mathematics education

Abstract

Accelerated algebra curriculum policies have come under fire recently for seemingly producing poor results for low-performing and high-performing students. This paper uses findings from a case study of 8th grade Algebra I recommendation and placement procedures at a medium-sized, predominately low-income Latino school district located in a major metropolitan area to analyze the meso (district) and micro (school) level forces that shape the implementation of accelerated algebra. Utilizing a conceptual framework that views algebra instruction as a resource allocated at the local level, we propose a practical ideal standard for algebra policy evaluation and utilize it to assess the effectiveness of the recommendation and placement procedures in the case study district. Findings were that teacher recommendations reliably predicted student success or failure in Algebra I 60% of the time, but that a substantial number of students performed either better or worse than expected. Regression analyses using a variety of available performance indicators produced a recommendation and placement model with increased power to predict student success. However, between-school variability in placement procedures suggests latent factors that bias recommendation and placement are at work and need further investigation. Implications are that placement procedures, rather than accelerated algebra policy itself, should be scrutinized as a possible factor in low performance.

Introduction: Significance and Purpose of Study

Though the drive to improve mathematics education in the U.S. dates at least from the 1950s (Schoenfeld, 2007), a relatively recent component of mathematics curriculum policy was the push to provide "algebra for all," (Moses, Kamii, Swap, & Howard, 1989), which was fueled by the recognition that algebra is a gateway to diverse benefits (Adelman, 2006; Gamoran & Hannigan, 2000; Rose & Betts, 2001, 2004; Smith, 1996; Spielhagen, 2006) and led to algebra being a required course for high school graduation in many states (Dalton, Ingels, Downing, & Bozick, 2007). Subsequently, algebra was accelerated and offered to middle school students (7^{th} and 8^{th} grades) in order to allow them to take more advanced math courses in preparation for college (Walston & McCarroll, 2010).

However, evidence has accumulated that ending remedial math courses in 7^{th}-9^{th} grades and placing all students in Algebra I in and of itself has not been associated with significant gains in mathematics achievement. Clotfelter, Ladd and Vigor (2012) found that in Charlotte-Mecklenberg schools, students affected by acceleration did less well on end-of-course tests in Algebra I and less well subsequently in Geometry and Algebra II, suggesting that placements and recommendations were flawed. Loveless (2008, 2013) found circumstantial evidence nationwide for "watering down" of courses and lower test scores associated with increases in Algebra enrollment, perhaps as a result of a place-all-students strategy unaccompanied by additional supports for misplaced students or teachers with mixed-ability classrooms. Nomi (2012) found that in Chicago Public Schools high-skills students who would have been tracked into Algebra I regardless of the existence of an accelerated mathematics policy, did less well in their accelerated

Algebra courses presumably because misplacements resulted in heterogenous classroom composition that challenged unprepared or under qualified teachers. Several studies have documented inconsistencies and biases in preparation, readiness assessment and placement into accelerated Algebra I (Liang, Heckman, & Abedi, 2012; Rosin, Barondess, & Leichty, 2009; Stein, Kaufman, Sherman, & Hillen, 2011; Walston & McCarroll, 2010; Waterman, 2010; Williams, Heartel, Kirst, Rosin, & Perry, 2011). The research has begun to coalesce around a consensus that, though accelerated algebra itself may be desirable from an equity and economic growth standpoint, serious problems exist with regard to placement that compromise the effectiveness of the policy.

This evidence of shortcomings and adverse effects in accelerated algebra policy, combined with the influence of Common Core Standards that replace Algebra I with a set of 8th grade integrated math standards, threatens to reverse the trend of accelerated Algebra-for-all and return Algebra I to the high school classroom, potentially erasing gains in numbers of students taking higher level college preparatory mathematics. This reversal has already been set in motion in California (Fensterwald, 2013).

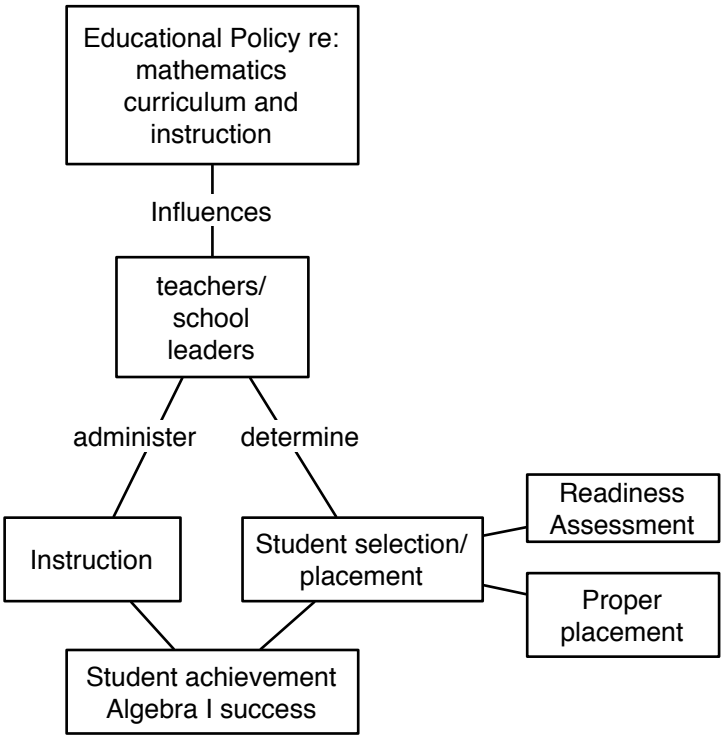
Despite the growing evidence that the success of accelerated mathematics policy is contingent on adequate preparation and accurate placement, little research has been conducted on the factors that influence algebra readiness assessment, recommendation, and placement at the meso (district) and micro (school) levels where it actually occurs. This study of algebra placement at one urban, low-income, high minority school district in California takes advantage of detailed administrative and achievement data to gauge the effectiveness of algebra recommendation and placement against a proposed practical ideal standard—success in Algebra I.

Conceptual framework

Legislators and state departments of education can set curricular policy that requires certain courses of study be offered at particular grade levels, but teachers and school leaders must make choices about how to allocate instructional resources to implement such a policy effectively. If these local decisions are not made in such a way that students have higher achievement, it does not follow necessarily that the course-requirement policy is flawed, but only that the local delivery of the course has not been optimized. For the purposes of this case study, the issue is the allocation of 8th grade access to Algebra I, which entails administering instruction and selecting the students who will receive the benefit of that instruction with the presumed goal of maximizing student achievement. Figure 1 illustrates the framework that informed analysis of the data in this study. Here, the focus is on how teachers and school leaders determine who is placed into Algebra, which is a function of both readiness assessment (recommendation) and proper placement—two separate, and not necessarily coordinated, administrative procedures.

We propose that it is reasonable to evaluate a policy against a conceptual *practical ideal*. In this case, the practical ideal would be an algebra placement system that is associated with a high proportion of success. Such a system would have three components: a) accurate diagnosis of algebra readiness, b) placement that follows the diagnosis and, c) resulting success in Algebra I.

Figure 1. Algebra Placement Framework



Methods

This study used descriptive statistics, *t*-tests and OLS regression analysis to gauge the effectiveness of the observed algebra readiness assessment and placement procedures in the 2011-12 school year at one medium-sized, low-income, high-minority school district.

The measure against which the success of the procedures was evaluated is implicit in the primary research question:

What would have been the best recommendation/placement procedure for optimizing Algebra I academic achievement, as measured by course marks and statewide standardized assessment, in the case study district?

This primary question is divided into three sub-questions that guided the analysis of the observed data:

1. To what extent did teacher recommendations reliably predict student course marks and end-of-course California Standards Test (CST) results in Algebra I in the four middle schools in the case study district?
2. Was there evidence of bias in course recommendations or placement?
3. To what extent should factors other than teacher recommendations have been included in Algebra I placement decisions in the case study district?

Research context, sample and data sources

The population of interest consisted of 1,558 7th graders who were either recommended for 8th grade Algebra I (*n*=825, 53%) or 8th grade Algebra Readiness (*n*=585, 38%). Most (87%) were Latino, with 7% White, 3% African American and 3% other. Though majority Latino, only 9% (*n*=142) of these students were classified as English Language Learners (ELLs). No information was available on eligibility for the National Student Lunch Program (a proxy for poverty), or on parent educational level. The district is located in a major metropolitan area and had in enrollment in 2012 of approximately 22,500 students in 13 elementary, four middle and three high schools.

It is important to note that this study is limited to a single district and therefore can make no claim to generalizeability to all districts, or even to districts in California. Probably the particulars of this case (proportions, regression coefficients, significantly predictive measures) will not hold universally. However, by closely exploring one district's recommendation and placement procedures without the constraint of seeking to prove a hypothesis, we were able to identify aspects of implementation that might occur

in other districts (discrepancies in teacher recommendations from school to school, placements that disregard recommendations) and that could, if not taken into consideration, confound other analyses of accelerated algebra policy.

Results

We began with descriptive analysis to determine what students were recommended by teachers for Algebra I in 8th grade, where they were placed subsequent to recommendation, and how they performed in Algebra I. Teachers recommended most (53%) 8th graders at the four middle schools for Algebra I, though 38% were recommended for Algebra Readiness and 9% were judged to be "in the middle". Most (64%) of those who were not recommended for Algebra I were not placed in Algebra I. But, interestingly, 209 students (36%) who were not recommended were placed in Algebra I. Students who were both recommended for Algebra I and subsequently placed there earned, on average, a grade of B- (2.61, expressed as grade points) in the first semester and B- (2.52) in the second semester, whereas the 209 students who were not recommended, but then placed in Algebra I, did slightly worse the first semester, earning a C (2.03 GPA) on average, but catching up the second semester with a B- (2.48) on average.

A two-sample *t*-test showed the first semester grade point difference between these groups was significant ($p \leq .0001$), but the second semester grade point difference was not significant, which suggests that on average, the recommendations for student placement were good and that the placements were not necessarily good in terms of predicting initial performance. However, students who were recommended for math

remediation, but for some reason were placed into Algebra I, ended up no better or worse in terms of second semester grade than students who were recommended for and placed in Algebra I. In addition, there was no significant difference between the two groups' CST scaled scores or between their proportions of students who scored proficient or advanced. It may be that algebra instruction itself addressed differing incoming skill levels, bringing the lower skilled students up. Or, conversely, the presence of lower skilled students in the Algebra I class might have had a negative influence on higher skilled students' performance, bringing their scores down.

However, data exploration revealed an interesting phenomenon: 45% (n=97) of the students who were *not* recommended for but placed in Algebra I scored higher than 381 (scale score) on the Algebra I California Standards Test (CST). Thus a substantial number of the students who would have gone into Algebra Readiness based on teacher recommendation alone were somehow placed in Algebra I and they *outperformed*, on average, the students who were recommended for and placed in Algebra I. Thus, teacher recommendations for Algebra Readiness can be described as 55% reliable and 45% unreliable.

Table 1 includes demographics and other indicators for the students who were recommended for Algebra Readiness in 8th grade, but were instead placed in Algebra I. These students are divided into two groups based on whether their CST scale score was below (properly recommended for Algebra Readiness) or above (mis-recommended for Algebra Readiness) the mean score for Algebra-recommended students (381). These two groups were similar demographically, but the mis-recommended/properly placed group had higher 7th grade course marks in 2010-11. Interestingly, the Pre-Algebra exam

benchmark scores (administered at the end of 7th grade) were not markedly different between the two groups.

Table 1. Recommended For Algebra Readiness, but placed in Algebra (*n*=209)

	Mis-recommended, properly placed (*n*=97*)	**Properly Recommended, misplaced (*n*=112)**
Ethnicity	83 (88%) Latino, 9 (10%) white, 2 (2%) other.	95 (85%) Latino, 10 (9%) white, 7 (6%) other.
2012 Language Classification	48% IFEP or RFEP, 52% EO	49% IFEP or RFEP, 4% EL, 47% EO
Attendance rate	96%	96%
Mean 2010-11, semester 1 grade	2.89 (B-/B)	2.31 (C)
Mean 2010-11, semester 2 grade	2.89 (B-/B)	2.05 (C)
Mean 2011-12, semester 1 grade	2.15 (C)	1.93 (C-/C)
Mean 2011-12, semester 2 grade	2.97 (B-/B)	2.07 (C)
Mean 2012 Algebra I CST scaled score	452	317
Mean 2012 Algebra I CST raw score	54	32
% Proficient or advanced 2012 Alg. I CST	100%	23%
Pre-Algebra Exam, benchmark 1	70	62
Pre-Algebra Exam, benchmark 2	73	65
Pre-Algebra Exam, benchmark 3	63	62
2010-11 Mathematics CST Raw Score	53	41

Table 2 describes the 741 8th grade students who were recommended for and placed in Algebra I. They also are divided into two groups: the 49% whose Algebra I CST scaled score exceeded the average of 381 (properly recommended and placed for Algebra), and the 51% who scored below-average on the CST (mis-recommended and placed in Algebra). As shown, the mis-recommended and misplaced group had lower grades in 2010-11, lower benchmark scores and lower prior year CST raw scores.

Table 2. Recommended For Algebra, and placed in Algebra (*n*=741)

	Properly recommended, properly placed (*n*=365)	Mis-recommended, misplaced (*n*=376)
Ethnicity	292 (80%) Latino, 31 (8%) white, 11 (3%) African American, 31 (12%) other.	332 (88%) Latino, 27 (7%) white, 15 (4%) African American
2012 Language Classification	54% IFEP or RFEP, 1% EL, 46% EO	47% IFEP or RFEP, 3% EL, 50% EO
Attendance rate	97%	96%
Mean 2010-11, semester 1 grade	3.61 (B+/A-)	2.94 (B-)
Mean 2010-11, semester 2 grade	3.55 (B+)	2.68 (B-)
Mean 2011-12, semester 1 grade	3.20 (B)	2.04 (C)
Mean 2011-12, semester 2 grade	3.11 (B)	1.95 (C-)
Mean 2012 Algebra I CST scaled score	440	324
Mean 2012 Algebra I CST raw score	52	33
% Proficient or advanced 2012 Alg. I CST	100%	33%
Pre-Algebra Exam, benchmark 1	82	70
Pre-Algebra Exam, benchmark 2	86	77
Pre-Algebra Exam, benchmark 3	80	70
2010-11 Mathematics CST Raw Score	53	43

School Analysis

The descriptive analysis continued with an examination of between-school variability. Table 3 shows the number and percentage students who were recommended for *Algebra Readiness*, but placed in Algebra for each middle school. Table 4 shows the number and percentage students who were recommended for *Algebra I* and placed in Algebra for each middle school. And table 5 shows the total number of students who were placed in Algebra I. Schools had various rates of following recommendations with placements. Overall, of the 950 students placed in Algebra I, only 462 (49%)—just under half—were placed properly in the sense that they did well in the course and on the standardized assessment.

Table 3. Recommended For Algebra Readiness, but placed in Algebra (*n*=209)

	Mis-recommended, properly placed (*n*=97)		Properly Recommended, misplaced (*n*=112)	
	n	%	*n*	%
Green Middle School	2	2%	40	36%
Brown Middle School	2	2%	28	25%
Red Middle School	1	1%	8	7%
Blue Middle School	92	95%	36	32%

Table 4. Recommended For Algebra, and placed in Algebra (*n*=741)

	Properly recommended, properly placed (*n*=365)		Mis-recommended, misplaced (*n*=376)	
	n	%	*n*	%
Green Middle School	87	24%	81	22%
Brown Middle School	125	34%	129	34%
Red Middle School	98	27%	145	39%
Blue Middle School	55	15%	21	6%

Table 5. Placed in Algebra (*n*=950)

	Not Recommended, but placed (*n*=209)		Recommended, placed (*n*=741)	
	n	%	*n*	%
Green Middle School	42	20%	168	80%
Brown Middle School	30	11%	254	89%
Red Middle School	9	4%	243	96%
Blue Middle School	128	63%	76	37%

Regression Analysis: Finding the Optimal Placement Procedure

We constructed three OLS regression models to investigate the effect of readiness measures on course marks. In each case, the dependent variable was Algebra I CST scale scores.

The first regression model used recommendation to place in Algebra as the only predictor of CST Algebra I scale scores was significant, but weak, accounting for about 1/60th of the variability in CST scores. The regression coefficient can be interpreted as indicating that a recommendation to place a student in Algebra I yielded a 14 point increase predicted scale score.

The second model used the end-of-year 7th grade Mathematics CST raw score as a predictor of Algebra I CST performance. This was a much better model compared to using recommendation alone. It accounted for 48% of the variability in Algebra I raw scores. The coefficient indicated that for every one-unit increase in the 7th grade math CST raw score, we saw a nearly a one-unit increase in predicted Algebra I raw score.

The best available model used a combination of all available data on student performance and demographics. Testing this combination for significance of each covariate generated a parsimonious model that included 2010-11 first and second semester grades and the third Pre-Algebra Benchmark Exam score, but not the placement in Algebra I recommendation. The 7th grade math CST raw score was significant in the model and added substantial predictive power. Together, these predictor variables accounted for more than a half (51%) of the variability in final Algebra I CST scores. The two additional Pre-Algebra Benchmark Exam scores were not significant, nor was the attendance rate. The beta coefficients from this model indicate that the 7th grade math CST raw score (or, presumably, the scale score) was the greatest predictor, followed by the second semester 7th grade course mark, followed by the first semester 7th grade course mark, followed last by the third Pre-Algebra Benchmark Exam score.

Summary of Findings

To what extent did teacher recommendations reliably predict student course marks and California Standards Test (CST) results in Algebra I? Algebra I and Algebra Readiness recommendations were reliable predictors of first semester Algebra I success at a rate of 60%, and unreliable at a rate of 40%, but recommendations proved unreliable for predicting second semester grade or CST performance.

Was there evidence of bias in course recommendations or placement? There was no evidence of systematic bias by ethnicity or language classification. However, between-school variability suggests school factors played a role and additional analysis is needed

to determine if there are socioeconomic or ethnic differences between schools that may account for different placement patterns.

To what extent should factors other than teacher recommendations be included in Algebra I placement decisions? Teacher recommendations did not prove valuable in this case study. Instead, 7th grade marks, 7th grade mathematics CST scores and one of the district's Pre-Algebra Benchmark scores were associated with good performance in Algebra I. These findings suggest it is possible to predict success based on existing measures, but that these measures were not used for placement in this case.

Discussion

In the face of a spate of recent studies that show unintended adverse or mixed positive and negative effects of accelerated algebra policy on student achievement, it is important to disentangle macro-level (state) curriculum policy from meso and micro level policy implementation procedures. As Loveless (2008, p. 10) points out, "No social benefit is produced by placing students in classes for which they are unprepared." Policy makers can approach the problem of preparation and misplacement in one of two ways: they can eliminate the risk of placing students in classes for which they are unprepared by eliminating the requirements for classes themselves, as California has decided to do, or policymakers can look for ways to improve preparation, recommendation and placement while continuing to require 8th grade Algebra. Many states will be facing this decision in coming months and years.

Broadly speaking, of course, no matter what course is taken, students need to be prepared and accurately placed. Policy makers and local officials can learn from local

efforts to expand availability of 8th grade algebra under NCLB and state policies. As districts look at how they change courses under new standards, new state requirements and a reconfigured Federal regulatory regime, it is important to look at placement results from the district perspective. The analyses in this study raise a number of issues for districts:

Student Placement and Assignment to Algebra: In this study, current models for determining student placement to Algebra I versus Algebra Readiness were unreliable. Teacher recommendations, in particular, were not predictive of academic success. Given the relatively good predictive power of 7th grade CST scores (a finding corroborated in other studies), should state policy-makers encourage districts to move away from "holistic" models and give more weight to achievement on standardized tests as a more objective criteria for determining Algebra I—or any mathematics—placement?

Equity in Student Placement: Wide variation and inconsistency across schools in Algebra I placement indicates that students with similar backgrounds and prior achievement may be assigned to different mathematics courses. Put another way, data from this case study suggest that there may have been less equity in Algebra I placement than supposed within schools and across schools in the same district. Should district placement policies be more closely monitored to encourage equity?

Student Success in Algebra: The data from this case study indicate that students who were not recommended for Algebra I but were, nonetheless, assigned to that course did as well as those initially recommended for Algebra by the end of second semester. Indeed, nearly half of those not recommended for Algebra outperformed those who were recommended. These data suggest that "marginal" mathematics students exceeded

teacher expectations and were able to function satisfactorily in Algebra I. Given these data, is the move to postpone student enrollment in Algebra I by pushing it to 9th grade under Common Core justified? Alternatively, might not the lack of statistically significant differences in Algebra I achievement (and NAEP scores; see Loveless, 2013) suggest a need to focus on the pedagogy and classroom practices used in the teaching of mathematics rather than the diagnostic tools used to determine readiness for Algebra?

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