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Universal Algebra I Policy, Access, and Inequality: Findings From A National Survey[1]

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Abstract: Many in the US view algebra as a gatekeeper to advanced study of mathematics, and increasing enrollment in algebra courses as a strategy to address unequal access to educational opportunity. As a result, universal enrollment policies, which require all students to complete Algebra I by grade 8 or 9, have garnered attention in school districts or states. Based on a view that school districts are the primary implementers of state and national policy in the US, this study surveyed a nationally representative sample of districts to investigate the prevalence of such policies and their relationship to algebra enrollment. Districts reported substantial increases in Algebra I enrollments in eighth grade, although ninth grade remains the most common year students enroll. Only 26% of districts reported having universal enrollment policies; in these districts, linear regression indicated that an association with higher eighth grade Algebra I enrollment was moderated by poverty level (measured by FRL). As a result, universal policies, while decreasing within-district disparities, may increase disparities between districts. These disparities may be explained by maximally maintained inequality (Raftery & Hout, 1993) and effectively maintained inequality theories (Lucas, 2001), which posit that more affluent groups take deliberate action to perpetuate inequalities.
Keywords: Algebra; educational policy; school district; access to education; opportunity

Política de álgebra universal I, acceso, y desigualdad: Resultados de una encuesta nacional
Resumen: Muchas personas en EEUU ven la álgebra como un portero para el estudio de matemáticas avanzadas y más inscripciones en cursos de álgebra como una estrategia para abordar el acceso desigual a las oportunidades educativas. La álgebra I en le nivel 8 o 9 se ha prestado atención a los distritos o estados escolares. En base a una visión de que los distritos escolares son los principales implementadores de la política estadual y nacional en los Estados Unidos, este estudio investigó una muestra de distritos para investigar la prevalencia de dichas políticas y su relación con la matrícula de álgebra. Los distritos reportaron aumentos sustanciales en las inscripciones de Álgebra I en le nivel 8, aunque la matrícula de le nivel 9 es más común. Sólo el 26% de los distritos relataron tener políticas universales de matrícula y regresión lineal indicaron que una asociación con inscripción superior en álgebra I de le nivel 8 fue moderada por el nivel de pobreza en esos distritos. Como resultado, al disminuir las disparidades dentro del distrito, las políticas universales pueden aumentar las disparidades entre los distritos. Esas disparidades pueden ser explicadas por la desigualdad máxima mantenida (Raftery & Hout, 1993) y teorías de desigualdad efectivamente mantenidas (Lucas, 2001), que argumentan que grupos más afluentes toman acciones deliberadas para perpetuar las desigualdades.
Palabras-clave: Algebra; política; escuela secundaria; acceso a la educación; oportunidad

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Universal Algebra I Policy, Access, and Inequality

Worldwide, many school systems are facing challenges to simultaneously increase levels of mathematics attainment and ensure access to substantive mathematics for greater numbers of students. In the US, this challenge is currently being played out in part through policy and practice debates over the topic of algebra. Positioned as a gatekeeper that governs students' opportunities to study advanced mathematics, Algebra I is often used as a cornerstone in U.S. policies aimed at increasing mathematics attainment (e.g., Achieve, 2008), global competitiveness (e.g., National Mathematics Advisory Panel, 2008), college and career readiness (e.g., United States Department of Education, 1998), and addressing unequal access to educational opportunities for students based on income level and school type (e.g., Moses & Cobb, 2001).

As a result, many policy initiatives and experimental programs have targeted enrollment in and successful completion of Algebra I (or its equivalent) at or before ninth grade as a strategy to increase access to and participation in higher levels of high school mathematics (Domina, McEachin, Penner & Penner, 2015; National Mathematics Advisory Panel, 2008). We refer to policies and programs based on this strategy as *universal Algebra I by ninth grade* (UA9).[2] These policies are of keen interest to a wide variety of stakeholders seeking to improve outcomes and reduce inequalities among U.S. students in mathematics. The perceived shift towards universal Algebra policies has not been accompanied by systematic research on the impact of such policies on enrollment or completion outcomes or the extent to which they increase participation among students in low-income communities. In short, we do not know how widespread such policies are and whether they have indeed produced the desired results of reducing inequality through increasing enrollment and successful completion of Algebra I for a greater number of students.

In this paper, we investigate the phenomenon of the universal Algebra I by ninth grade policy. Using U.S. school districts as the unit of analysis, we explore current policy trends in how districts are responding to the pressures to increase Algebra I enrollments and completion rates. We consider the landscape of policy and practice related to universal Algebra I by ninth grade and focus, in particular, on the relationship between these policies and districts serving low-income populations. The questions driving our analysis in this paper are:

1. To what extent have school districts in the US adopted universal Algebra I policies?
2. What are current patterns in Algebra I course taking in the US?

[2] This term is consonant with Stein, Kaufman, Sherman, & Hillen's (2011) conception of "early and universal algebra."

3. In what ways are Algebra I course requirement policies related to Algebra I access and enrollments in different types of districts, particularly those serving students in low-income communities?

We consider these questions using the results from a survey of a nationally representative sample of school districts designed to measure district algebra policy and students' opportunities to learn algebra. As school districts are responsible for setting policies that determine access to algebra, we selected school districts are the unit of analysis.

Universal Algebra I Policies and Student Outcomes

In response to the work of Moses and Cobb (2001), policymakers and researchers in the mid-2000s began working in earnest to increase access to Algebra I by changing or eliminating selective enrollment procedures that had been used to determine readiness to take an Algebra I course[3]. One specific means to implement this change is then notion of "curricular intensification," a term used by Domina et al. (2015) to describe efforts to increase academic rigor for all students, such as UA policies (by grade 8 or 9). These efforts assume that "students learn more in academically challenging educational environments" (p. 277) and that universal requirements can equalize learning opportunities across social strata. Research on UA policies have shown mixed results, both in favor of and against UA policies. Mathematics educators and policymakers have used these empirical results as the basis for drawing battle lines on either side of the UA policy issue. In a review of 19 empirical studies that examined universal algebra policy implementation in several schools, districts, and one state (California), Stein, Kaufmann, Sherman, & Hillen (2011) reported several promising findings. Across the studies that provided enrollment data, these policies, some of which required Algebra I by eighth grade (UA8) and some by ninth grade (UA9), led to a greater number of students passing Algebra I in all cases. In all but one study, researchers found improvements in student achievement following the implementation of a UA policy, including studies of large systems and states such as California (Williams, Haertel, & Kirst, 2011), Milwaukee (Ham & Walker, 1999), and the Washington, D.C. metro area (Burris, Heubert, & Levin, 2006). In particular, UA policies improved access and achievement in ways that narrowed race-based achievement gaps (e.g., Burris & Welner, 2005; Edmunds et al., 2012). These studies are cited by UA policy supporters as evidence that such policies increase both access to algebra and increase the number of students in historically marginalized populations who successfully complete Algebra I.

Critics of UA policies point to less positive outcomes. Some reports indicate that students and teachers have had difficulty meeting the high-stakes expectations associated with universal access policies, with some states reporting failure rates in Algebra I courses in excess of 50% (Achieve, 2009a; Clotfelter, Ladd, & Vigdor, 2015). A study of UA9 policies in the Chicago Public Schools noted that while the number of students passing Algebra I increased, pass rates as an overall percentage of the student population decreased slightly overall (Allensworth, Nomi, Montgomery, & Lee, 2009). Domina et al. (2015) used district-level panel data collected during California's unevenly implemented move to increase enrollments in Algebra I in eighth grade to examine the effect of these increases on 10th grade mathematics achievement. Using district-level data from the California

[3] Universal Algebra policy is an umbrella term that refers to a set of administrative rules designed to increase access to one form or another of an Algebra I course. The nature of those courses, whether they are heterogeneously or homogeneously grouped, and what content is taught in the name of Algebra I, is beyond the scope of this paper. Some findings related to course-specific constructs are addressed in Steele, Remillard, Baker, Keazer, and Herbel-Eisenmann (2016) and in forthcoming publications from the project.

Basic Educational Data System and California High School Exit Exam, researchers found a negative correlation between districts' eighth grade enrollment rates and math scores in 10th grade in several content domains, ranging from number sense and pre-algebra to Algebra I and geometry. When controlling for district size, these researchers found that the largest one-third of districts (with 850 or more students in eighth grade), which included the large urban districts in the state, were exclusively responsible for this effect. Outcomes were more positive in the other two-thirds of districts. Domina et al.'s recent finding may provide support for a claim initially made by Loveless in a 2008 report, the M*isplaced Math Student*. Loveless argued that schools enrolled an increasing percentage of students in eighth grade Algebra I before they were adequately prepared to learn the material. He also claimed that the population of "misplaced" students was disproportionately low-income and minority. In essence, Loveless suggests that policies that increase enrollment may indeed be damaging, because they make successful completion less likely, and argues that sound policy must attend to both access and achievement in the form of course completion.

These mixed and differential findings merit further scrutiny. Is a push in the name of equalizing access in fact damaging one of the key constituencies that it aims to support? Domina et al.'s (2015) study is revealing, not only for its findings, but for the evidence it provides of uneven application of a state's universal enrollment policy. The large-scale studies that exist primarily look at course enrollment and successful completion as broad inputs and outputs, and usually within a single district system. These course-grained studies have been interpreted by policy pundits in divergent ways: Some commentators refer to Algebra I in eighth grade as "the new normal" (Loveless, 2013, p. 31); others suggest that widespread universal Algebra I polices may not be as prevalent or as evenly applied indicated by reports (Biddle, 2013). To understand the ways that policy, enrollment, and course completion interact as systems, data about multiple districts that vary by state and local policy context, demographics, size, and urbanicity is needed to begin to explore the policy-practice nexus in greater depth. The purpose of this paper is to report on a systematic investigation of the prevalence of universal algebra policies within school districts in the US and the relationship of these policies to Algebra I enrollment and completion.

Perspectives on Reducing Inequality through Increased Access

Approaches that seek to reduce inequality of educational opportunity tend to focus on increasing assess to valued resources for those most often excluded. Klugman (2013) refers to this approach as embracing a "resource deprivation" perspective, which views "high-level curricula as opportunities to learn and argue that inequalities of access to high-level curricula result from disadvantaged families' and schools' limited resources" (p. 114). Because it is viewed as the first step in a college-preparatory mathematics sequence, the opportunity to take Algebra I as early as possible is an example of high-level curricula that is currently differentially available to advantaged and disadvantaged families. From this perspective, one way to narrow inequalities in opportunity is to increase the possibility that underprivileged youth will have access to the same valued and consequential resources that more advantaged youth have.

Klugman (2013) argues that the resource-deprivation perspective is incomplete because it does not take a systemic view of distribution of resources. Instead, the focus on increasing access for one segment of the society ignores the tendency for social systems to maintain inequalities. Specifically, scholars taking a systemic perspective on distribution of resources have noted a tendency for members of socioeconomically advantaged groups to behave in ways that seek further and additional resources for themselves (and their children) when less advantaged groups are being provided access to valued resources and opportunities (Klugman, 2013; Lucas, 2001). This tendency is explained through the lens of *effectively maintained inequality* (EMI) theory (Lucas, 2001), which asserts that "socioeconomically advantaged actors secure for themselves and their children some degree of advantage wherever advantages are commonly possible" (p. 1652).

Lucas (2001) proposed EMI theory to highlight the active role that advantaged actors play in securing socially valued resources, in contrast to *maximally maintained inequality* (MMI) theory (Raftery & Hout, 1993), which focuses on the ways members of advantaged groups are better positioned than others to benefit from new educational opportunities. EMI theory asserts that, in the face of increasing access to valued educational resources, socioeconomically advantaged groups exploit qualitative distinctions to secure benefits.

Klugman's (2013) analysis of Advanced Placement (AP) offerings in California illustrates the importance of considering the behaviors of the advantaged when disadvantaged groups are given access to valued resources. He found that increased efforts to offer AP courses in schools serving students from low-income households were matched by parents from advantaged communities mobilizing and obtaining a wider array of AP options at their children's schools. To look at just one end of the socioeconomic continuum is to assume that disadvantage is equivalent to the "absence of advantage" (Brooks-Gunn, Duncan, Klebanov & Sealand, 1993).

Our analysis of school districts' policies and practices around the highly valued course of Algebra I considers districts across the socioeconomic spectrum. As discussed in the following section, we view districts as key players in policy implementation and creation within a state and national context. We also consider the particular demographic features of the district, including size, urbanicity, and poverty.

Framing the Policy Context: A Focus on School Districts

School districts are the primary unit of analysis in this study, consistent with strong traditions of local control and the absence of federal jurisdiction over education practices in the U.S. Although they must comply with policies of their home states, school districts enjoy substantial autonomy and play a critical role in interpreting and enacting state policy (Spillane, 2006). They also set their own policies addressing graduation requirements, course sequencing, and enrollment; as a result, there is substantial variation in how Algebra I is structured and taught, as well as the criteria for entrance.

School districts also operate within influential contexts. They are nested within states, and state mandates drive their policies, often in response to national dialogues (Spillane, 2006). Although the US does not have a national curriculum, initiatives at the national level impact states and districts differentially, depending upon the pathways chosen and the availability of supplemental funding for policy initiatives (e.g., No Child Left Behind [NCLB] Act, 2001). States are responsive to national initiatives, as the following examples illustrate.

To increase consistency across states and districts and expand access to quality mathematics instruction, professional organizations such as the National Council of Teachers of Mathematics (NCTM) have produced school mathematics standards that have, to varying extents, informed policy and practice (NCTM, 1989). More recently, an independent advocacy organization, Achieve Inc., developed the America Diploma Project, a series of analyses and policy briefs that assessed rigor of secondary school curriculum and outcomes. These analyses led to the development of college- and career-ready curriculum (CCRC) recommendations for states regarding English and mathematics graduation requirements (Achieve, 2009). At the time of the study, 35 states had adopted these recommendations, which included increased graduation requirements, efforts to align state assessment systems to college- and career-ready standards, and the creation of accountability and reporting systems that supported CCRC outcomes for students. These changes were fairly politically benign, unlike the consideration of curriculum standards that followed.

Following on this work, Achieve and the National Governors Association (2010) developed the Common Core State Standards (CCSS) initiative, subsequently incentivized by federal funding competitions such as Race to the Top (U.S. Department of Education, 2009). The mathematics standards (CCSSM) were adopted by 46 U.S. states and territories at the time of this study, and at the secondary level, represented a significant increase in rigor for many states (Carmichael, Martino, Porter-Magee, & Wilson, 2010; Schmidt & Houang, 2012). The mathematics standards also represented a shift of content typically included in Algebra I to earlier grades (seventh and eighth grade in particular), although the standards themselves are silent on when and how to offer a first algebra course. As such, CCSSM marked an important shift in content recommendations for states, but policy recommendations for implementation remained the purview of states and districts.

District policies are also related to the demographics of the district. We focus on three demographic categories: urbanicity, size, and district poverty. Urbanicity describes the location-type of a school district (i.e., urban, suburban, town, and rural). School districts from the same urbanicity type tend to share other characteristics; for instance, urban schools tend to be larger, have lower per-pupil funding rates, and have poorer student outcomes than other urbanicity types (e.g., Anyon, 1997). Districts of similar size are likely to share certain structural characteristics; for example, smaller districts may have fewer schools and administrative staff, allowing for more systemic coherence. Urbanicity and district size can be related (urban districts tend to be large; rural districts tend to be small), but not always directly correlated. For instance, both large urban and suburban districts may have large bureaucratic structures but may differ in per-pupil funding. Student wealth/poverty is a third facet that influences access to resources and academic outcomes (Burris & Welner, 2005; Lipman, 2011). Districts serving students with similar levels of poverty may also share other characteristics and may respond to policy influences in similar ways (Klugman, 2013). Our analytical approach assumes that district demographics are related to (as opposed to caused by or as causing) variation in district policy.

Methods

To address our research questions, we analyzed data from a large-scale, nationally representative sample of school district leaders in the United States, inquiring about algebra policy in middle and high schools.

Analytical Categories

In order to consider the ways in which the U.S. educational context and varying local conditions and demographics might mediate relationships between policy and access, we identified a set of key analytical categories to conceptualize dimensions of the survey sample: a) state policy; b) district size; c) urbanicity; and d) poverty. In structuring our survey sample, we ensured representativeness with respect to these district characteristics across the United States. We also made use of these characteristics throughout our analysis.

State policy context. In order to categorize state policy with respect to mathematics requirements, we used Achieve's (2009) college- and career-ready curriculum (CCRC) criteria, which asked states to require four years of challenging secondary mathematics courses. We drew data from Achieve, which categorized states into four groups based on progress towards CCRC implementation: planned by 2011, planned by 2015, planned but with no date specified, or no plans to increase requirements. At the time of the survey in 2012, CCRC 2011 represented districts in the throes of implementing new policy, with CCRC 2015 districts likely in transition. In addition, the study took place in the early stages of the adoption of the Common Core State Standards, meaning that many districts surveyed were likely in the process of analyzing changes in the mathematics content of the standards and determining course and policy implications based on those changes.[4]

District size. We identified districts as "large" or "small" based on their enrollments. We labeled large districts as those with more than 4,000 students and small districts as those with fewer than 4,000 students. Nationwide, large districts accounted for 19% (the largest fifth of school districts) and small districts accounting for 81% of the districts (NCES, 2011).[5]

Urbanicity. We use the term urbanicity to describe the population density of the community in which a school district is located. This term is based on the NCES (2011) construct of Urban-Centric Locale Codes. NCES categorizes the community a school district is located into four large-grain categories: urban, suburban, town, and rural. We combined suburban and town into a single category due to similarity in population density.

Poverty. To compare districts in terms of wealth distribution and poverty, we considered the percentage of students in each district eligible for the Free or Reduced Priced Lunch (FRL) Program (NCES, 2011). We categorized districts into four FRL quartiles, based on the population of all U.S. school districts, and classified districts with the highest percentage of students eligible for FRL as high poverty (Quartile 4).

Data Collection

We drew on two data sources in this paper: data from a survey of school districts that the LANDSCAPE Algebra Policy in Middle and High Schools developed for this study and the Common Core of Data from the U.S. Department of Education's National Center for Education Statistics (NCES, 2011).

Survey development. We created the survey using total survey design (Fowler, 2002) with the goal of minimizing measurement error by considering all aspects of the survey design process at the beginning, and writing survey questions with end-analyses in mind. Drawing on literature from mathematics education and policy research, as well as work we have collectively done with school districts, we developed an initial set of questions, and then piloted open-ended versions with twelve district math leaders. Analyzing their responses, we developed closed-form items, which an expert panel then reviewed. We piloted the web-based survey with 38 districts and revised following cognitive interviews. The final survey, deployed May 2012, had 522 items contained in 47 questions. The survey probed district leaders about district policies for graduation, student enrollment patterns, decisions pertaining to Algebra I, and the forces that influenced those decisions. (See Appendix for copy of survey.)

Sampling. Using the Common Core of Data (NCES, 2011), we identified all local education agencies in the US, what we call "local school districts," with the exception of charter schools,

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[4] The broader project included case studies of twelve districts, nested in four states in different geographic regions of the US. Our data from these case studies indicates that at the time of the study, the districts within the four states in question were squarely in an analysis mode with respect to the standards, and had not implemented sweeping changes based on their implementation.

[5] NCES collects data about all public schools and school districts in the U.S. on an annual basis. State education agency officials supply descriptive information about school districts, schools, students, and staff, including demographics and fiscal data. See nces.ed.gov/ccd.

specialty school districts, and districts with fewer than 41 students. The total population included 13,075 school districts. Using a power analysis, we determined that our sample should include 1,000 districts to be able to detect a group mean difference at the .05 significance level. For the purposes of this study, we stratified our sample with respect to state policy grouping (CCRC), district size, and urbanicity. We sampled disproportionately based on district size (40% large districts and 60% small districts) and state policy (25% from each grouping) in order to be able to make arguments about the relationship between state and district algebra policy and location. We sampled proportionally by urbanicity.

We sought to administer the survey to one individual within each district most clearly responsible for decisions about mathematics education. We hypothesized that these individuals would be well-informed to answer questions about Algebra I policy and practice. We then identified the individuals by searching district websites and state databases; they tended to be mathematics coordinators or assistant superintendents for curriculum and instruction. In some districts, the individuals were superintendents, principals, or teachers. In the initial contact, we asked the individuals to confirm their responsibility for district policies concerning Algebra I, and to pass the invitation to the appropriate person if necessary.

Final dataset and response bias. In total, we contacted 2,332 districts, invited in three waves, to participate in the survey, yielding 1,192 responses over a six-month period. Following data cleaning to account for substantially incomplete and duplicate responses, the final dataset contained survey responses from 993 district leaders, for an overall response rate of 43%. We then linked these responses with district-demographic and census-tract data (NCES, 2011). The distribution of the districts with respect to state policy grouping and urbanicity was statistically representative of our intended sample, showing no evidence of response bias by policy grouping or by urbanicity — respectively, $\chi^2(3) = 0.721$, $p > .05$ and $\chi^2(2) = 3.994$, $p > .05$. Our response rate with respect to district size, however, was skewed in favor of larger districts— $\chi^2(1) = 26.439$, $p < .05$. Because the sample is somewhat biased in relation to district size we do not extrapolate from findings related to this factor. We used post-stratification weighting to correct for the unequal probabilities of selection across cells when deriving national estimates.

Data Analysis

We employed both descriptive and inferential statistics to build a picture of the national landscape of Algebra I policies and enrollment patterns and identify factors that were significantly related to those policies and enrollment patterns. The analysis relied on a small subset of items, drawn from different sections of our survey.[6] In these 10 items, district representatives shared information about algebra policies, enrollment, changes in enrollment patterns, and pass rates. By drawing on a large, nationally representative sample, we are able to report on trends in school districts across the country. Our unit of analysis was the school district. In our analysis, used probability-weighted data approximating a simple random sample of the 13,075 school districts in the US. [7]

[6] A full research report of all survey findings from the LANDSCAPE Study (Steele et al., 2016) is available on the Consortium for Policy Research in Education publication website: http://www.cpre.org/LANDSCAPE.
[7] Our analysis treats the school district as the unit of analysis. We do not present data on the percentage of students who are impacted, like others in the field (e.g., Loveless, 2008). For instance, we report on the percentage of school districts that require Algebra I completion to graduate from high school, but we do not report on the percentage of students for whom Algebra I completion is required to graduate.

We conducted the data analysis using SPSS 21, employing the Complex Samples module. To understand the prevalence in the US of each policy and outcome in the survey, pursuing our first research question, we estimated relative frequency distributions. As we utilized weighted data, we report the estimated percentages of respondents in the population rather than actual sample frequencies, along with standard errors when appropriate. Within analyses, we used listwise deletion to remove cases with missing data.

Addressing our first and second research questions, we used our analytical categories (state policy groupings, district size, urbanicity, FRL) to compare districts to see if these characteristics were related to district policy, relying on cross-tabulations to describe the distribution of the data.

In order to address our third research question about access and enrollments, we used linear regression to predict eighth and ninth grade district enrollment percentages in Algebra I based on UA9 policy and our analytical categories (i.e., our set of district-level covariates). We estimated two linear regression models: a main effects model, and a model including interaction terms to elucidate the relationship between UA9 policy and enrollment percentage across districts of different sizes, locales, and relative poverty levels. Given that initial linear regressions predicting Algebra I enrollment percentages indicated that there was no statistically significant interaction between district size and UA9 policy in either grade, we removed this interaction term from both the eighth and ninth grade models. The full model is given in Equation 1:

$$Enroll = \beta_0 + \beta_1 UA9 + \beta_2 Siz + \beta_3 Urb + \beta_4 Pol + \beta_5 Pov + \beta_6 UA9 \times Urb + \beta_7 UA9 \times Pov + \varepsilon$$

where *Enroll* is the district Algebra I reported enrollment percentage, *UA9* is an indicator denoting districts with UA9 policies, and the other covariate symbols denote main effects of the four analytic categories as well as interactions of UA9 policy with locale and poverty level.

Additionally, and also in connection with our third research question, our second model used a linear regression to predict district pass rates for Algebra I based on UA9 policy and our analytical categories as shown in Equation 2:

$$PassRate = \beta_0 + \beta_1 UA9 + \beta_2 Siz + \beta_3 Urb + \beta_4 Pol + \beta_5 Pov + \varepsilon$$

where *PassRate* is the district's reported Algebra I pass rate, given as a percentage, and all other notation is as described previously.

Findings

Our analysis of the survey data of U.S. school districts had several purposes. One purpose was to describe the landscape of Algebra I policy and course-taking patterns across the U.S. A second purpose was to examine the extent of the relationship between course-requirement policies and increased Algebra I enrollments. The third purpose was to consider the ways that such course-requirement policies were related to algebra access in different types of districts, with a specific focus on students in low-income communities. Our findings are organized into two parts. First we describe patterns in Algebra I enrollment policies in general, using our analytical categories to examine any relational trends. We then turn to our data on patterns in course taking practices and pass rates, looking at the national landscape and then focusing specifically on districts that have adopted UA9 policies. We consider the impact that UA9 policies appear to have on different types of districts, focusing, in particular, on FRL rate as an approximate measure of average student poverty level.

Landscape of Algebra I Policies in the US

In this section, we present our findings on the use of enrollment policies by school districts in the US to influence whether and when Algebra I is taken. We provide an overview of reported Algebra I policies across school districts and their distribution across our analytical categories.

In 2012, when the survey data were collected, it was nearly universal for school districts in the US to require Algebra I for high school graduation, with 91.5% (*SE* 1.2) of districts having such a requirement. These graduation requirements largely reflected state-level policy; of districts with an Algebra I graduation requirement, only 8.1% (*SE* 1.3) reported that their requirement exceeded their state's minimum policy. UA9 policies, that is, district policies that required all students to complete Algebra I by or before ninth grade, were not the norm. Across all districts in the US, the percentage that had a UA9 policy was 26.0% (*SE* 1.7). Of districts requiring Algebra I for graduation, 22.1% (*SE* 1.6) required Algebra I by the end of ninth grade and another 6.4% (*SE* 1.0) required Algebra I by eighth grade. Here again, district policy seems to reflect state policy: of the 6.4% of districts requiring eighth grade Algebra I, 43.6% were from Minnesota, which had a state-level eighth grade Algebra I mandate.

The survey asked respondents to indicate the age of their district's Algebra I policies. The majority of respondents, 68.2% (*SE* 1.9), reported their policies to be over five years old. Only 12.1% (*SE* 1.1) of districts reported policies that had been changed within the last one to two years. In other words, the age of the majority of policies does not suggest recent changes in district Algebra I requirements.

When we used our analytical categories to explore the distribution of districts that had UA9 policies, we found that several types of districts had higher incidence of UA9 policies. Still, even the highest incidences of UA9 policies were modest and several categories had very small percentages. The highest incidence of UA9 policies across policy groupings occurred in districts located in states that planned to enact college and career-ready curricula in mathematics (CCRC) by 2015, at 37.7% (*SE* 3.2). Rural districts had the highest incidence by urbanicity at 28.5% (*SE* 2.5) and districts in the lowest free and reduced-price lunch (FRL) quartile had the highest incidence, when compared by district poverty, at 33.4% (*SE* 3.6). These percentages are in contrast to other categories of districts, such as districts in the highest quartile of poverty (measured by FRL), where the incidence of UA9 polices was below 20%.

We used logistic regression to examine whether having a UA9 policy could be predicted by particular district characteristics. Controlling simultaneously for all analytical categories, we found CCRC policy grouping [$\chi^2(3) = 21.63; p < .001$] and urbanicity [$\chi^2(2) = 6.68; p < .05$] were significantly associated with UA9 policy adoption. Post-hoc comparisons indicate that compared to districts with no plan to increase graduation requirements, districts with CCRC required for all students by 2011 have about 120% greater odds, and those with CCRC required by 2015 have about 160% greater odds, of having implemented UA9 policies by the time of the survey. We also found that urban districts had 72% lower odds of having mandated UA9 than suburban districts. That is, urban districts were significantly less likely to require Algebra by ninth grade. (The likelihood of having a UA9 policy did not differ significantly between rural and suburban districts.)

It is not surprising that state policy grouping is the strongest predictor of whether a district has a UA9 policy. States that adopted Achieve's (2009) College and Career-Ready curriculum committed to requiring four years of mathematics for graduation of high school. Given that Algebra I is generally considered the most basic course to count for high school credit, a CCRC curriculum requires Algebra I be completed by ninth grade by default. In fact, it is somewhat surprising that the incidence of UA9 policies in districts located in states with or planning to have CCRC policies is not much higher. Regardless, this finding suggests that the adoption of UA9 policies might be driven primarily by state-level policy requirements rather than individual districts' initiatives.

Taken together, these findings suggest that, in general, school districts were not using course requirements policies to increase Algebra I enrollments. Rather, districts that adopted UA9 requirements appeared to mirror state mandates. The decreased chance of urban districts having a UA9 policy may, at first glance, be surprising, since several reports on such programs have focused on urban districts. Stein et al. (2011), however, note that minimal research has been undertaken on such policies, and existing studies focus on settings where access to algebra has been in question, such as urban districts. Our analysis suggests that the illustrative cases of UA9 policies in urban districts may not be typical.

Algebra I Course Taking

In order to investigate the relationship between UA9 policies and Algebra I course taking, we explored Algebra I enrollment patterns reported in the survey. We were particularly interested in whether higher levels of eighth and ninth grade Algebra I enrollment occurred in districts that had adopted UA9 policies, whether these policies were also associated with lower pass rates or increases in students repeating Algebra I, and whether the presence of these policies was associated with increased access to Algebra I for students in low-income communities. In this section, we first report our overall findings on Algebra I enrollments in the US. We then consider whether districts with UA9 policies report higher levels of Algebra I enrollment and greater increases in these enrollments than districts without. Finally, we explore whether enrollment and increases are related to particular district characteristics such as size, urbanicity, and poverty.

Algebra I enrollment patterns. Figure 1 shows how each district responded to the question: "Indicate the percentage of students that are currently enrolled in Algebra I or its equivalent at each of the described [6-10] grade levels," by relative frequency of Algebra I enrollment for grades 8-10. Across all districts, we found that students most commonly took Algebra I in ninth grade; as shown in Figure 1, 58.6% of districts reported enrolling at least 70% of ninth graders in Algebra I, including close to 13.4% of districts that reported enrolling 100%. It is important to emphasize that the frequencies in Figure 1 refer to districts reporting the proportion of students taking Algebra I at each grade level. Given that districts vary in size, these data do not indicate the overall number of students taking Algebra I at a given grade. Also, some students enrolled in Algebra I in grades 9 or 10 may have be taking it a second time.

The next largest proportion of students enrolled in Algebra I was in eighth grade, although the distribution of eighth frequencies was multimodal. Overall, 72.0% of districts reported enrolling less than 50% of eighth graders in Algebra I. Just under one-third (31.8%) reported enrolling between 20% and 35% of their eighth graders in Algebra I. The most common response in the grade column represents close to 12.3% of districts that reported enrolling between 0% and 5% their eighth graders in Algebra I (most common response). As expected, the 10th grade distribution was positively skewed, with 60.5% of the districts reported enrolling 10% or less of 10th graders in Algebra I. These data indicate that although only 26.0% of districts require Algebra I to be taken at or before ninth grade, most students are nevertheless enrolled in Algebra by that time.

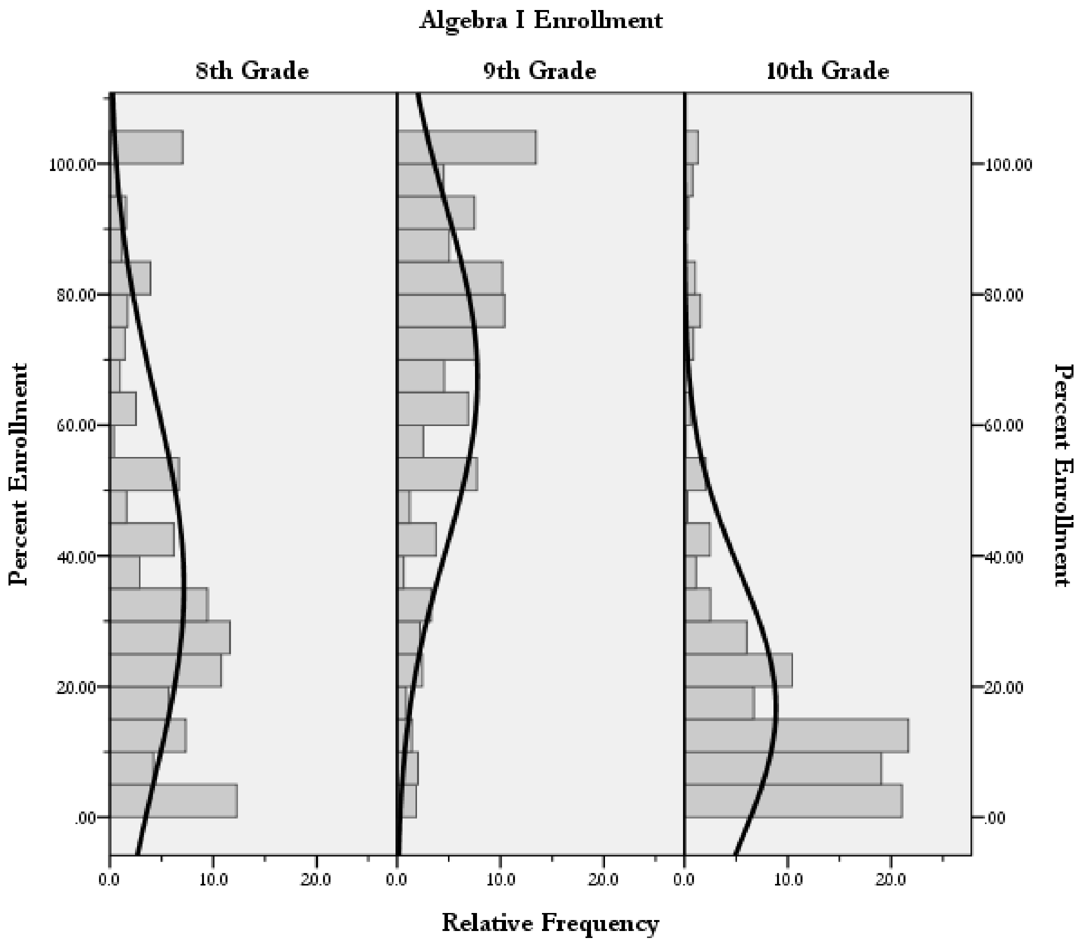

Figure 1: District reported enrollment (as a percentage of cohort) in Algebra I in grades 8, 9, and 10.

When asked about shifts in enrollment over the past five years, 23.4% (*SE* 1.7) of districts indicated that they experienced "a great deal" of increase in Algebra I course taking in eighth grade, while 33.3% (*SE* 1.9) reported "somewhat" of an increase. When asked about increases in Algebra I enrollment in ninth grade over the past five years, 18.3% of districts (*SE* 1.6) reported "a great deal" of increase and 24.3% (*SE* 1.8) indicated "somewhat." In other words, districts reported seeing substantial increases in eighth grade enrollment of Algebra I over the five years prior to 2012, but many also reported increases at the ninth grade level. This pattern is in line with other studies indicating that students appear to be taking Algebra I earlier than in previous years (Loveless, 2013, Stein et al., 2011). Importantly for understanding the role of policy in these changes, our findings suggest that this increases occurred even though district policies requiring it for graduation or at a particular grade level had not changed notably during that period.

In order to explore the possible relationship between UA9 policies and access to algebra, we compared Algebra I enrollments in eighth and ninth grade in districts with and without policies requiring Algebra I by ninth grade.[8] Overall, we found that UA9 policies were associated with higher

[8] For the purposes of this analysis, we include districts with UA8 policies in the group UA9 (those requiring Algebra I by the end of ninth grade.

enrollments in eighth, but not ninth grade.[9] Using a linear regression, we found that after adjusting for districts' size, urbanicity, and relative poverty level, UA9 districts enrolled more students in eighth grade Algebra I than non-UA9 districts by 16 percentage points. In ninth grade, we found no significant difference in enrollment between UA9 and non-UA9 districts, on average ($p > .05$). We note here that our analysis does not allow us to attribute differences in enrollment patterns to these UA9 policies per se. Nevertheless, our findings suggest strong predictive relationships between the presence of such policies and particular enrollment differences, suggesting that these policies, perhaps along with other associated variables not measured, are likely to be an influencing factor.

Relationships between UA9 policy, Algebra I enrollment, and district characteristics. We hypothesized that the relationship between UA9 policies and observed Algebra I enrollment, increases in enrollment, and pass rates would vary depending on district characteristics such as size, urbanicity, or relative poverty level. With this relationship in mind, our primary analytical models included terms representing the posited interactions between the UA9 policy indicator and districts size, urbanicity, or relative poverty level. We calculated estimates of the change in enrollment percentage after adjusting for the effects of other model variables on districts' algebra enrollment. Overall, we found that district poverty level was related to both reported enrollment levels and pass rates, with UA9 policies having a weaker correlation with Algebra I enrollment in poorer districts (FRL quartile 4) than in other districts. Additionally, as discussed in the following pages, we found that across urbanicity categories and FRL quartiles, the relationship between UA9 policies and eighth and ninth grade algebra enrollments varied.

Table 1 provides model estimates for a linear regression predicting eighth grade enrollment using UA9 policy and our analytical categories. Both Model 1, without interaction terms, and Model 2, with interaction terms, are included. The Model 2 results indicate that there were significant interactions between district urbanicity [$F(2, 813) = 4.99, p < .05$] and poverty level [$F(3, 812) = 3.31, p < .05$], and the UA9 policy indicator.

[9] Statistical models are displayed in Table 1 for eighthgrade enrollment and Table 3 for ninth grade enrollment.

Table 1
Linear Regression Predicting eighth grade Algebra I Enrollment Percentage[a]

	Model 1		Model 2	
	Coefficient	*SE*	*Coefficient*	*SE*
UA9 policy	15.67***	2.862	-6.91	5.102
Small size	2.28	2.081	2.44	2.093
Urbanicity (*ref* = suburban)				
Urban	5.12	2.818	.88	2.939
Rural	-2.94	2.499	-7.62**	2.812
Policy grouping (*ref* = no plan to increase graduation requirements)				
CCRC by 2011	-12.86***	3.014	-12.49***	2.991
CCRC by 2015	-3.41	3.145	-3.65	3.072
Plan to increase graduation requirements	-9.87**	3.052	-10.02**	3.016
Poverty level (*ref* = FRL quartile 4)				
FRL quartile 1	16.24***	3.582	11.03**	4.181
FRL quartile 2	8.50**	3.222	1.80	3.789
FRL quartile 3	0.45	3.269	-4.56	3.810
UA9 policy by urbanicity (*ref* = suburban × UA9)				
Urban × UA9			17.95*	8.441
Rural × UA9			15.72**	5.440
UA9 policy by poverty level (*ref* = FRL quartile 4 × UA9)				
FRL quartile 1 × UA9			16.34*	8.186
FRL quartile 2 × UA9			19.65**	7.004
FRL quartile 3 × UA9			13.89*	7.024
R^2	.14		.16	

Sources: Urbanicity, FRL quartile, and size from NCES (2011). CCRC requirements from Achieve (2009).
Note. * $p < .05$; ** $p < .01$; *** $p < .001$; FRL = free-and-reduced lunch eligibility percentage; CCRC = College- and Career-ready Curriculum; UA9 = universal Algebra I by or before ninth grade
[a] $n = 836$

To illustrate the significant interactions from Table 1, Table 2 shows the adjusted mean enrollment percentages for UA9 and non-UA9 districts within each demographic category along with the difference in adjusted means for each group reported in the right-hand column. These enrollment discrepancies indicate that although eighth grade Algebra I enrollment tended to be higher for UA9 districts than for non-UA9 districts in every urbanicity category, the difference is considerably larger among urban and rural than among suburban districts. As simple contrasts of values in the right-hand column in Table 2 show, the adjusted mean difference in enrollment percentage between districts with and without UA9 policies is about 18 percentage points higher for urban than for suburban districts, and about 16 percentage points higher for rural than for suburban districts. The mean differences in enrollment between districts with and without UA9 policies were 16, 20, and 14 percentage points higher for districts in FRL quartiles 1, 2, and 3, respectively (more affluent), than for districts in FRL quartile 4 (highest poverty). Adjusted mean enrollment percentages for districts with and without UA9 policies by FRL quartile demonstrate that while eighth grade Algebra I enrollment tended to be higher for districts with, rather than without, UA9 policies at each poverty level, the difference in mean enrollment percentages between UA9 and non-UA9 districts was much lower among the poorest districts in FRL quartile 4. In other words, the relationship between UA9 policies and eighth grade Algebra I enrollment was diminished in the lowest-income districts, in that their enrollment levels were generally low regardless of UA9 policies.

Table 2
Adjusted means of district enrollment percentages by UA9 policy and demographic category for grades 8 and 9[a]

Grade 8	UA9 policy	No UA9 policy	Difference
Urbanicity			
Urban	57.44	33.92	23.52
Suburban	38.61	33.04	5.57
Rural	46.71	25.42	21.29
Poverty Level			
FRL quartile 1	60.42	39.76	20.66
FRL quartile 2	54.50	30.53	23.97
FRL quartile 3	42.38	24.17	18.21
FRL quartile 4	33.05	28.73	4.32
Grade 9	**UA9 policy**	**No UA9 policy**	**Difference**
Urbanicity			
Urban	60.86	62.22	-1.36
Suburban	69.55	63.48	6.07
Rural	64.38	73.04	-8.66
Poverty Level			
FRL quartile 1	63.20	59.14	4.06
FRL quartile 2	54.42	67.10	-12.68
FRL quartile 3	66.34	72.45	-6.11
FRL quartile 4	75.76	66.30	9.46

Sources: Urbanicity, FRL quartile, and size from NCES (2011); CCRC requirements from Achieve (2009).
[a] $n = 836$

We took a similar approach to examine the relationship between UA9 policy and ninth grade Algebra I enrollment across different district characteristics. As shown in Table 3, results from Model 2 indicated that there were significant interactions between district urbanicity [$F(2, 816) = 3.66$, $p < .05$] and poverty level [$F(3, 815) = 3.79$, $p < .05$] and the UA9 policy indicator. Policy grouping was also significantly associated with ninth grade Algebra I enrollment percentage [$F(3, 815) = 6.80$, $p < .05$].

Table 3
Linear Regression Predicting ninth grade Algebra I Enrollment Percentage[a]

	Model 1		Model 2	
	Coefficient	*SE*	*Coefficient*	*SE*
UA9 policy	-3.69	2.838	16.84**	5.385
Small size	-0.87	2.028	-0.86	2.032
Urbanicity (*ref* = suburban)				
Urban	-3.51	2.437	-1.26	2.855
Rural	5.18*	2.447	9.56***	2.681
Policy grouping (*ref* = no plan to increase graduation requirements)				
CCRC by 2011	7.56**	2.756	7.44**	2.724
CCRC by 2015	-3.65	3.077	-3.45	2.994
Plan to increase graduation requirements	4.16	2.941	3.90	2.873
Poverty level (*ref* = FRL quartile 4)				
FRL quartile 1	-10.19**	3.185	-7.15	3.659
FRL quartile 2	-6.65*	3.041	0.81	3.214
FRL quartile 3	0.89	2.891	6.16	3.178
UA9 policy by urbanicity (*ref* = suburban × UA9)				
Urban × UA9			-7.42	6.033
Rural × UA9			-14.72**	5.443
UA9 policy by poverty level (*ref* = FRL quartile 4 × UA9)				
FRL quartile 1 × UA9			-5.40	6.951
FRL quartile 2 × UA9			-22.15**	7.387
FRL quartile 3 × UA9			-15.57*	6.740
R^2	.07		.11	

Sources: Urbanicity, FRL quartile, and size from NCES (2011). CCRC requirements from Achieve (2009).
Note. * $p < .05$; ** $p < .01$; *** $p < .001$; FRL = free-and-reduced lunch eligibility percentage; CCRC = College- and Career-ready Curriculum; UA9 = universal Algebra I by ninth grade
[a] $n = 838$

Unlike the interactions in the eighth grade enrollment model, both of the interactions predicting ninth grade enrollment were disordinal, suggesting that UA9 policies have positive relationships with ninth grade Algebra enrollment in some types of districts, but negative relationships with enrollment in others. This phenomenon is illustrated in Table 2. For instance, adjusted mean enrollment percentages for districts with and without UA9 policies by urbanicity suggest that among suburban districts, ninth grade Algebra I enrollment tended to be higher in UA9 than in non-UA9 districts, but among rural districts, ninth grade enrollment tends to be higher in non-UA9 than UA9 districts. Little difference in ninth grade Algebra I enrollment proportions occurs between UA9 and non-UA9 districts in urban areas.

The pattern of adjusted mean differences in ninth grade enrollment percentage between districts with and without UA9 policies across the FRL quartiles, again shown in Table 2, suggests an interaction that is counterintuitive on the surface; districts in FRL quartile 4 have higher mean differences in ninth grade Algebra I enrollment if they have UA9 policies than if they do not have such policies than districts in FRL quartiles 2 and 3. Put another way, UA9 policies appear to be negatively associated with ninth grade enrollment in districts in the middle 50% of the poverty range, but positively associated with enrollment in districts in the highest and lowest poverty quartiles. This finding mirrors two previously reported findings: Algebra enrollments in eighth grade are correlated with district poverty level, regardless of policy. Wealthier districts are likely to have higher eighth grade enrollments. For middle-quartile districts, on the other hand, UA9 policies appears to matter for eighth and ninth grade enrollments, but in opposite ways. The higher Algebra I enrollments found in eighth grade are offset with lower enrollments in ninth grade, suggested in Table 2.

Relationships between UA9 policy, reported Algebra I pass rates, and district characteristics. We conducted a linear regression of the UA9 policy indicator and all of the analytical categories on passing rates that district leaders reported, and found that UA9 policy and reported Algebra I passing rates were not related [$F(1, 780) = 0.39, p > .05$]. The R^2 fit statistic for this model was .15. Using both omnibus F tests and t-tests, we found that, compared to larger districts, controlling for other factors, small districts' algebra pass rates were 5.7 percentage point higher [$F(1, 781) = 30.81, p < .001$]. Algebra I pass rates were also inversely related to the proportion of students eligible for FRL [$F(3, 779) = 22.30, p < .001$]. Specifically, districts in FRL quartile 1 (fewest FRL eligible students) reported pass rates that were 12 percentage points higher than districts within FRL quartile 4; whereas, districts in FRL quartiles 2 and 3 reported pass rates that were 6 and 4 percentage points, respectively, higher than FRL quartile 4. Finally, using omnibus F-tests, we found that pass rates were positively associated with urbanicity [$F(2, 780) = 3.28, p > .05$] and CCRC policy grouping [$F(3, 779) = 2.93, p > .05$]. As a robustness check, we identified six districts as multivariate outliers that may have unduly influenced the results based on Mahalanobis distance values, including five districts that reported Algebra I passing rates of less than 10%. When we removed them from the analysis the results were not notably different.

In summary, among districts with UA9 policies, urban districts and those in the FRL quartile 4 appeared to experience much smaller increases in eighth grade Algebra I enrollments than other types of districts and enrolled a lower proportion of students in Algebra I in eighth grade. As we might expect, given the eighth grade enrollment patterns, urban and poorer districts had a higher percentage of students enrolled in Algebra I in ninth grade than rural and wealthier districts in FRL quartiles 2 and 3. Taken together, these findings suggest that the relationship between UA9 policy and enrollment was diminished in urban and poorer districts. Additionally, although Algebra I pass rates were not related to UA9 policy, they were related more generally to relative poverty levels.

Discussion

In this section, we examine our findings to shed light on nationwide trends in Algebra I policies and course enrollment patterns across different types of school districts. In particular, we discuss our findings regarding how access to algebra is distributed across districts and the related implications for equity of opportunity. Overall, our findings raise questions about several assumptions about algebra policy and practices and, at the same time, add support to other claims made about enrollment patterns. More significantly, our findings also allow us to speculate on the limits of access-focused policy approaches for increasing equality of opportunity through participation in Algebra.

Questioning the Predominance of Universal Algebra Policies

Our first research question asks about the extent to which school districts in the US have adopted universal Algebra I policies. Our findings raise questions about several myths regarding the widespread implementation of UA9 policies, enrollment of eighth grade students in Algebra I, and associated increases in failure rates of Algebra I courses. Despite high levels of interest in and rhetoric about both the advantages and dangers associated with increasing Algebra I participation (i.e. Loveless, 2008; Stein et al., 2011), we did not find widespread evidence that school districts were using course requirement policies to increase early Algebra I enrollments. Just one quarter of districts reported having such a policy. In general, districts seemed to be following the lead of state policy, rather than implementing district-specific requirements. Our data indicate that very few states had UA9 policies at the time of the survey. Moreover, we found that more than two-thirds of the policies had been implemented more than five years previously. In other words, districts did not seem to be using enrollment mandates as an active strategy to increase or ensure access to algebra.

Further, urban districts were less likely to report having UA9 policies than suburban or rural districts. This finding may be surprising, given that much of the national rhetoric on increasing algebra participation is focused on urban districts. It is possible that the focus on studying algebra policy in large urban districts, like those investigations that Stein et al. (2011) reviewed, may skew public perception about where such policies are being implemented and with whom.

In response to our second research question, our findings provide insight on Algebra I course enrollment in the US. As we showed earlier, and discuss in more detail below, districts report experiencing substantial increases in Algebra I enrollment at the eighth grade level. That said, our findings do not substantiate the assertion that "taking algebra in eighth grade is the new normal" (Loveless, 2013, p. 31). Ninth grade remains the most common grade for Algebra I enrollment by a considerable amount. The mean percentage of ninth graders enrolled in Algebra I across all districts was 67%, while the mean percentage for eighth grade was 35%. It is important to note that because districts vary in size, these percentages cannot be interpreted as proportions of all eighth or ninth grade students in the US.

Loveless's (2013) assertion that increased enrollments in Algebra I in eighth grade set many of these students up to fail does not appear to be the case, at least as district officials reported. We did not find that increases in Algebra I course taking in eighth grade accompanied reports of substantial increases in failure rates. Neither were failure rates correlated with the presence of a UA9 policy. It is possible that district representatives reported failure rates conservatively; however, this finding aligns with, and extends to a nationally representative sample of districts, an important outcome of UA9 policy that Stein et al. (2011) identified: greater numbers of students of color and from low-income communities enroll in algebra and complete it successfully.

Confirming Increases in Algebra I Enrollment

Our survey findings also confirmed several claims often made about current trends in Algebra I courses taking. Both Loveless (2013) and Stein et al. (2011) noted patterns of increase in Algebra I enrollments in eighth grade. Although districts report that the majority of their students still take Algebra I in ninth grade, over 50% of districts reported recent increases in Algebra I enrollments in eighth grade and over 40% reported recent increases in ninth grade. Loveless's data came from student's self-reports on NAEP reports. Stein et al. drew on published research; our data are directly reported from the school districts representatives responsible for managing these courses and monitoring enrollment changes. The demographic and contextual factors most associated with increases in Algebra I enrollments and general levels of enrollments in eighth or ninth grade in our data also align with other reports. To put it directly, wealth and policy context were the strongest predictors of both enrollment levels and increases, but sometimes in less predictable ways.

Our third research question considers the relationships between Algebra I course requirement policies and access to Algebra I in different types of districts. Our findings suggest that district wealth may mediate the impact of policy aimed at increasing access. In most types of districts, having a UA policy was associated with higher levels of eighth grade enrollment in Algebra I, regardless of whether the policy targeted eighth or ninth grade. Only 20% of districts with UA policies required students to take Algebra I by eighth grade; the remaining 80% required it by ninth grade. These policies, however, were correlated with higher enrollments and reported enrollment increases in eighth grade, rather than in ninth grade. This finding suggests that curricular intensification (Domina et al., 2015) caused by UA9 policies may have a trickle-down effect. That is, the presence of UA9 policies and practices associated with them raises the stature of early algebra in general, leading to more students being placed prior to the required year. As Algebra I in eighth grade comes to be seen as a viable option, schools and districts implement programs and curricula that institute Algebra I as a standard middle-school offering and begin to encourage and support greater levels of participation.

Notably, however, UA9 policies do not appear to matter in the same way for all districts. In districts in the quartile serving the highest proportion of students on FRL, UA9 policies appeared to have a larger effect on enrollment in ninth grade than in eighth grade. These differential relationships between UA9 policies and eighth grade Algebra I enrollments among districts in different income categories raise questions about the relationship between UA9 policies and equal access to algebra. In the following section, we return to theories on social stratification discussed earlier to consider explanations for this finding.

UA9 Policies, Access, and Equality

UA9 policies appear to provide more students in low-income communities with access to Algebra I in general by increasing enrollments in ninth grade. At the same time, because they are also associated with increased enrollments in eighth grade in districts not in the highest FRL quartile, these policies may contribute to increased stratification in access to algebra. In the end, trickle-down curricular intensification in higher-income districts may offset positive outcomes realized through increased access to algebra in ninth grade in low-income districts.

This observed movement on both ends of the educational landscape points to a critical challenge associated with attaining equality of opportunity through increased access to those underserved—the tendency for social systems to maintain inequalities. The two social theories, *maximally maintained inequality* (MMI) (Raftery & Hout, 1993) and *effectively maintained inequality* (EMI) (Lucas, 2001), provide explanations for this tendency. Both theories explain how expansion of access and opportunity to less privileged groups is unlikely to reduce educational inequalities. MMI theory asserts that members of advantaged groups are better positioned than others to benefit from new opportunities. EMI theory holds that socioeconomically advantaged groups tend to mobilize to seek advantages over those gaining access through targeted policies, by exploiting qualitative distinctions in resources when possible.

The finding that eighth grade enrollments in algebra in general were inversely related with district poverty levels illustrates an effect of MMI; Algebra I is seen as a gateway to an advanced math track and a means of obtaining socially-valued knowledge, and school officials and families in socioeconomically-advantaged districts generate opportunities for greater numbers of students to gain access to this commodity. The finding that, among UA9 districts, those with higher levels of poverty do not experience an increase in eighth grade algebra enrollments, while all other types of districts do, illustrates an effect of EMI. When districts use course requirements to provide all students with access to a valued resource, such as Algebra I by ninth grade, taking it in eighth grade is seen as a qualitative mark of distinction that more advantaged districts seek. As Klugman (2013) found in his study of increased Advanced Placement (AP) course offerings in schools serving students from low-income households in California, parents and school personnel from advantaged communities often mobilized to obtain higher value resources for their students.

Our findings support Klugman's (2013) claim about the limits of the resource-deprivation approach to reducing inequality. By focusing exclusively on increasing access to socially valued resources for targeted populations, it assumes that the problem is with those who lack resources and ignores how other groups mobilize to maintain inequalities. By viewing the district as the unit of analysis and examining the role of district enrollment policies, our findings reveal how policies aimed at reducing inequality *within* districts may be related to increased inequality *between* districts. Curriculum reforms that treat educational outcomes as commodities to be distributed, or redistributed, at a critical juncture are unlikely to counter the social forces described by Klugman, which treat educational resources as a zero-sum game. As we discuss in the following section, efforts to address educational inequalities in the system and consider across the entire system, while challenging to implement, may be more likely to increase access.

Implications for Educational Policy and Practice

Algebra I, as the official introduction to algebra, plays a provocative and complex role in the U.S. education system. It has the potential to provide access to valued knowledge that sits at the threshold of a pathway to advanced mathematics learning and, at the same time, serves as a distinguishing token of accomplishment. In spite of broad interest in and scrutiny of the Algebra I course, the way it is positioned in debates and policy rhetoric as a symbol of equality and access may overstate its potential in a highly stratified system. It is evident that providing students access to consequential educational opportunity does not achieve equality. As a consequence, determining the most productive ways for school districts to proceed is not straightforward.

What role might UA9 policies play in districts' efforts to increase broad participation in algebra? We believe these policies have modest potential. The cases where such policies have been adopted suggest that they may help to address the challenge of flawed selection practices, which result in inequitable access to Algebra I, at least within school districts (Stein et al., 2011). At the same time, our findings also suggest that the impacts of such policies depend, in part, on the demographics of the district. As a result, increased implementation of universal policies may exacerbate differences between districts.

It is evident that achieving educational equality involves more than simply placing more students in Algebra I or adopting universal algebra requirements. One essential implication from our finding that UA9 policies do not appear to increase failure rates, however, is that districts would benefit from adopting systematic and unbiased methods of placing students in early Algebra while providing them with additional supports. At the same time, addressing inequalities in a system and across systems cannot begin with eighth or ninth grade. It involves increasing opportunities for successful mathematics learning across the school system, beginning in the elementary grades. In addition, states and districts would benefit from reducing emphasis on resource-deprivation approaches and increasing emphasis on equity approaches. Rather than locating the problem in those who lack valued resources, such approaches target the needs of marginalized groups and address ways that traditional educational practices and institutional structures reduce access (Herbel-Eisenmann, Keazer, & Traynor, in press).

Limitations and Future Research

Our study has several limitations that also have implications for further research. Using a survey to collect data from a large sample of school districts allowed us to construct a nationally representative sample and produce findings that shed light on policies and practices associated with Algebra I across the nation. Indeed, to our knowledge, ours is the first study offering such insights. At the same time, this approach has limitations in the level of detail we could glean from any one district. As a result, the proposed explanations for the patterns we found using the survey data are partly speculative. In addition, our survey relied on self-report from a district representative to provide details on existing policies and practices, including graduation requirements, enrollment percentages and recent increases, and Algebra I pass rates. It is possible, depending on the structure of the district, that some respondents did not have all the information required and may have provided estimates or incorrect information. Depending on the inclination of the respondent, it is also possible that statistics that would shed a positive light on the district, like pass rates, were over reported.

Our findings press the educational research community to dig both more systematically and more deeply into the ways in which policy is enacted, how those policies translate into change at the district, school, and classroom levels, and where important policy levers might lie. How are UA9 policies implemented in districts that have them? And what types of results are these districts experiencing? For non-UA9 districts, what criteria are used to determine placements in Algebra I? What approaches are being used to enhance readiness for and ensure successful completion of Algebra I for the increasing number of students taking the course in eighth grade? Moreover, in order to fully understand the role that a sought-after course like Algebra I plays in the educational landscape, researchers must examine both ends of the continuum, considering its impact for all groups, not just within a single school, but across schools and districts. These are questions that need to guide future studies in districts across the US.

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