Contact Email: Julia.bloom-weltman@aemcorp.com
Title: Building an Equitable STEM Pipeline: Benefits of Taking Algebra 1 in Eighth-Grade
Abstract:

Background:
Policymakers argue for expanding eighth-grade Algebra 1 course-taking to improve students' mathematic literacy (National Mathematics Advisory Panel, 2008) because this is a "gatekeeping" course for advanced Science, Technology, Engineering, and Math (STEM) courses in high school. Taking Algebra 1 earlier, gives students adequate time to take additional STEM courses before graduation. Postsecondary success in STEM includes taking more and higher-level STEM courses in high school (Glennie et al., 2016). To complete advanced STEM courses in high school, students must complete Algebra 1 by eighth-grade (Loveless, 2013). For several decades policies have emerged increasing eighth-grade Algebra enrollment (Domina et al., 2015) from 16% in 1990 to 47% in 2011 (Loveless, 2013).

Though enrollment in advanced mathematics courses (i.e., Algebra 1 or higher) has increased, course-taking gaps remain, with higher enrollments among White and Asian students compared to Black and Hispanic students (Dalton et al., 2007). Minorities are underrepresented in STEM fields (NSF, 2017); this may be related to inadequate preparation in high school, including taking fewer advanced STEM courses (Dalton et al., 2007; Hinojosa et al., 2016) and delaying Algebra 1 until high school (Dougherty et. al. 2015). Yet, minority students in advanced courses are just as likely to pursue postsecondary STEM as their White peers (Tyson et al., 2007).

Increasing enrollments in eighth-grade Algebra 1 may be viewed as a positive outcome of decades of reforms. Some research indicates increased enrollments in eighth-grade Algebra 1 are positively associated with achievement (Heppen et al., 2012), particularly for the lowest achieving students (Ma, 2005), while other findings show policies mandating enrollment are negatively associated with achievement (Clotfelter, Ladd, & Jacob, 2012). Some find no relationship between increased enrollment and gains on national mathematics assessments (Loveless, 2013). Research examining effects of policy changes on achievement is largely correlational and subject to selection bias (Loveless, 2013). To more fully discern the impact of course timing on student outcomes, more sophisticated causal models are needed.

Purpose:
Pathways for STEM careers are not equitable and research must examine benefits of and access to eighth-grade Algebra 1 (Spielhagen, 2006). This poster draws on the National Assessment of Educational Progress (NAEP) and the Civil Rights Data Collection (CRDC) to replicate and build on the Brown Center Report on Advanced Math in Eighth-grade (Loveless, 2013) that investigated relationships between state variation in advanced math enrollment to achievement. We include CRDC reported at the school and LEA levels to explore issues with equitable access and achievement gaps.

Research Questions:
Our research builds on the Brown report with the following questions:

1. Are eighth-grade enrollments in advanced math related to states' math scores on NAEP and course passage rates on the CRDC? Do trends vary by students' race/ethnicity?
2. Is there a relationship between states' change in course enrollments and changes in NAEP scores? Did states experience gains on NAEP concurrent with increases in eighth-graders taking advanced math?
3. Is increasing the percentage of students in advanced level math courses associated with declines in mean scores?
4. How did changes in one states' Algebra 1 policy requirement impact achievement?

Setting and Population/Participants/Subjects:
We will use the NAEP assessment data on students' mathematics knowledge in grade eight and information on course-taking completed through student surveys. This study will use 2010-2011, 2012-2013, 2014-2015 NAEP state-level data, which is based on a sample. The CRDC includes data related to providing equal opportunities for students in public schools across the country; we will use the data elements provided on STEM access (number of courses), course-taking (number of students), and passing classes (number of students) (ED OCR, 2016). Collected at school and district levels, data are disaggregated by student race/ethnicity, sex, disability, and English Learner status. Drawing on the 2011-2012, 2013-2014, and 2015-16 CRDC universes of all U.S. public schools (approximately 95,000 each collection), we will focus on schools with eighth-grade Algebra 1 student enrollment and count of students passing (more than 14,000 each collection).

Research Design:
We propose drawing on the NAEP and CRDC surveys to replicate and build on the Brown report (Loveless, 2013), which analyzed state-level data from the NAEP from 2005-2011, which asked two questions related to the relationships between: 1) increased eighth-grade enrollment in advanced math and achievement on eighth-grade NAEP and 2) increased enrollment in advanced math and achievement in advanced STEM classes. We include the CRDC data because it also allows for a more drilled down analysis because the CRDC is at the school and LEA levels, not just at the state levels. While there have been high-profile state policies regarding Algebra 1, we know that many districts extend or modify these policies further and the CRDC allows for this more nuanced approach.

Data Collection and Analysis:
We will evaluate associations between eight-grade advanced math enrollment and math scores using two national data sets. First, drawing on publicly available data from the 2011-2015 NAEP survey, we propose to examine national enrollment changes in eighth-grade math classes and associations between advanced math course enrollment (Advanced Math, Algebra 1/2, and Geometry) and state NAEP math scores (Math Composite, Algebra). These analyses will update work conducted by Loveless (2013), which examined data from the 2005-2011 NAEP.

Next, drawing on three CRDCs, we will examine associations between eighth-grade Algebra 1 enrollment and passing. Our analyses will be restricted to schools that report eighth-grade enrollment. We will disaggregate enrollment and students passing Algebra 1 by race/ethnicity and sex. We will also explore other analytic methods using the CRDC to understand the sensitivity of our findings to other methods, including longitudinal logistic regression models (e.g., fixed-effects, account for omitted time-invariant characteristics).

As our replicated analyses are still correlational in nature, we will also examine difference-in-differences methods to investigate Minnesota's policy change requiring Algebra 1 in eighth-grade starting with the class of 2015 (see Research Question 4). We will ask the causal question: How did changes due to the policy result in changes to achievement course-taking and graduation? We will compare Minnesota schools to schools in other nearby states before and after the policy change.

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