Economics of Education Review 58 (2017) 141–161

Contents lists available at ScienceDirect

Economics of Education Review

journal homepage: www.elsevier.com/locate/econedurev

Objective course placement and college readiness: Evidence from targeted middle school math acceleration☆

Shaun M. Dougherty[a], Joshua S. Goodman[b,*], Darryl V. Hill[c], Erica G. Litke[d], Lindsay C. Page[e]

[a] University of Connecticut, USA
[b] Harvard University, USA
[c] Wake County Public Schools, USA
[d] University of Delaware, USA
[e] University of Pittsburgh, USA

ARTICLE INFO

Article history:
Received 5 October 2016
Revised 30 March 2017
Accepted 4 April 2017
Available online 7 April 2017

ABSTRACT

Advanced math coursework can affect college and labor market outcomes, yet discretionary placement policies can lead to differential access at key points in the college preparatory pipeline. We examine a targeted approach to course assignment that uses prior test scores to identify middle school students deemed qualified for a college preparatory math sequence. Accelerated math placement of relatively low-skilled middle schoolers increases the fraction later enrolling in Precalculus by one-seventh, and by over one-third for female and non-low income students. Acceleration increases college readiness and intentions to pursue a bachelor's degree. Course placement rules based on objective measures can identify students capable of completing rigorous coursework but whom discretionary systems might overlook.

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1. Introduction

Mathematics has long been regarded as essential for both individual and national economic success. Numerous microeconomic studies have shown that mathematical skills, high school coursework and college majors predict individuals' labor market earnings (Altonji, 1995; Altonji, Blom, & Meghir, 2012; Brown & Corcoran, 1997; Grogger & Eide, 1995; Levine & Zimmerman, 1995; Rose, 2004; Weinberger, 1999). Standardized measures of nations' math skills also strongly predict macroeconomic growth (Hanushek & Woessmann, 2015). Concerns triggered by the launch of Sputnik in 1957 and by the publication of "A Nation at Risk" in 1983 show that policymakers have for decades been calling for increased proficiency in math among American students as a national imperative (Gardner, Larsen & Baker, 1983; Tate, 1997).

Schools have, however, struggled to increase the proportion of students, particularly those from disadvantaged backgrounds, who successfully complete a sequence of math courses that prepare them for either the workforce or for quantitative training at the postsecondary level. Recent efforts to improve access to rigorous coursework have focused on early exposure to Algebra I, in part because it often precedes a sequence of courses culminating in Calculus and is thus seen as a gatekeeper course required for college-preparatory math (Adelman, 2006).[1] Such efforts have been motivated in part by observational research suggesting that early exposure to Algebra I is associated with future academic success (Gamoran & Hannigan, 2000; Smith, 1996; Stein, Kaufman, Sherman, & Hillen, 2011) and that completion of the follow-on coursework sequence strongly predicts later college success (Long, Conger, & Iatarola, 2012).

Not all students have equal access to Algebra I at earlier grades, however, in part because of differences in academic skills and school offerings (Conger, Long, & Iatarola, 2009). Even conditional

☆ This research was made possible by a collaboration between the Wake County Public School System and the Strategic Data Project, housed in Harvard's Center for Education Policy Research. We are grateful for feedback from Chris Avery, David Deming, Eleanor Dillon, Anna Egalite, Maria Fitzpatrick and Melinda Sandler Morrill, as well as from seminar participants at the University of Connecticut, University of Pittsburgh, Carnegie Mellon, North Carolina State University, Columbia University, APPAM, AEFP, SREE and AERA. Melanie Rucinski provided excellent research assistance. We gratefully acknowledge institutional support from the Taubman Center for State and Local Government at Harvard. Any errors are our own.

* Corresponding author.
E-mail addresses: shaun.dougherty@uconn.edu (S.M. Dougherty), joshua_goodman@hks.harvard.edu (J.S. Goodman), darryl_hill@mail.harvard.edu (D.V. Hill), litke@udel.edu (E.G. Litke), lpage@pitt.edu (L.C. Page).

http://dx.doi.org/10.1016/j.econedurev.2017.04.002
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[1] The traditional sequence until recently has been Algebra I, Geometry, Algebra II, Precalculus and Calculus. The new Common Core standards have begun to change the early part of this sequence involved but has not affected the broader debate over whether and how to expose students to more rigorous coursework in early grades.

on such factors, talented but disadvantaged students may be overlooked by the process through which math courses assignments are made, as course placement generally involves substantial discretion by school officials. To address these issues, many school districts and states have implemented universal algebra policies that mandate all ninth, or even eighth, graders enroll in Algebra I (Silver, 1995). Partly as a result of such policies, eighth grade Algebra I enrollment rates have more than doubled in the past two decades, from 15 percent in 1990 to 34 percent in 2012, with additional growth in the proportion of eighth graders completing even higher math courses.[2] Nevertheless, substantial gaps by race and income remain (Stein et al., 2011).

The "Algebra-for-All" movement has also generated concerns that universal access may harm both those students underprepared for more rigorous coursework and more highly skilled students whose curricula are diluted to adapt to the new skill-level of the average enrollee (Loveless, 2008; Schneider, 2009). Such universal policies have begun to fall out of favor. For example, in 2013, California backed away from a state requirement enacted in 2008 that all eighth graders take Algebra I. Instead, some systems have begun to explore a targeted approach that increases access to college-preparatory math coursework but only for students deemed sufficiently prepared for such rigor. We investigate one such model of targeted middle school math acceleration implemented in the 2010-11 school year by North Carolina's Wake County Public School System (WCPSS). Specifically, we focus on the impact of the policy on math course enrollment and success for students at the margin of acceleration.

WCPSS, concerned about both levels of and inequitable access to rigorous math coursework, instituted a targeted enrollment strategy designed to increase advanced math course-taking for students predicted to succeed in such courses. The district announced that assignment to an accelerated track leading to Algebra I in eighth grade would be based on a student's predicted probability of success in that subject. Specifically, if a student's available prior test scores predicted at least a 70 percent probability of passing a standardized algebra test, the student would be recommended for enrollment in that accelerated track. That threshold corresponded to about the 20th percentile of the district's skill distribution, implying that 80 percent of students were eligible for acceleration under the new policy.[3] The remaining 20 percent would take coursework leading to Algebra I in ninth grade.

We study the two earliest cohorts affected by the policy, for whom eligible students were initially accelerated in seventh grade to Pre-Algebra and whom we can observe through eleventh grade. A regression discontinuity design comparing those just above and below the eligibility threshold allows us to document five important facts about the relatively low-skilled students at the margin of acceleration. First, acceleration has no clear short-run impact on test scores. Second, accelerated students generally pass but rarely excel in their more rigorous courses, largely earning Cs and Ds. Third, one-seventh of students initially accelerated in seventh grade remain in the accelerated track to take Precalculus by eleventh grade, suggesting a fairly but not totally leaky pipeline. Fourth, conditional on initial acceleration, persistence rates in the pipeline differ greatly by income and gender, with acceleration increasing Precalculus enrollment rates by over 40 percentage points for non-low income students and over 30 percentage points for female students, relative to nearly no impact on low income and male students. Fifth, middle school math acceleration improves college readiness scores and college aspirations, increasing the fraction of students intending to enroll in four-year colleges by over 20 percentage points. As we discuss, these impacts on college readiness may be driven by a combination of exposure to the advanced mathematics curriculum as well as exposure to a higher-performing peer group, on average. Such changes to course exposure and peer composition are likely a feature of many targeted acceleration policies that seek to move lower-performing students into a more homogeneously high-performing setting.

These findings make three primary contributions to the literature. First and most importantly, we show that basing course assignment on objective measures of student skill helps identify students whom, conditional on ability, a discretionary system might overlook but who are capable of persisting in a college preparatory math track. Just as disadvantaged students are assigned to lower quality teachers (Clotfelter, Ladd, & Vigdor, 2005; 2006; Jackson, 2009; Kalogrides & Loeb, 2013; Sass, Hannaway, Xu, Figlio, & Feng, 2012), so too are they assigned to less rigorous coursework, even compared to their schoolmates of similar academic skill. We show in Dougherty, Goodman, Hill, Litke, and Page (2015) that the new assignment rule substantially diminished income and race gaps in course assignment, similar to recent work on universal screening policies to remedy such gaps in assignment to gifted and talented classrooms (Card & Giuliano, 2015; Grissom & Redding, 2016). We show here that initial acceleration leads to long-run increases in the fraction of students pursuing college preparatory coursework, particularly for female and non-low income students. In other settings, switching to decision processes focused on objective quality measures has improved success rates for otherwise overlooked individuals (Blank, 1991; Goldin & Rouse, 2000). We provide evidence of similar results in an educational setting.

Second, we provide the first estimated impacts of a clearly defined, targeted math acceleration policy, complementing prior studies of universal or more vaguely defined policies to increase early exposure to algebra. In 1997, Chicago eliminated remedial coursework and required that all ninth graders take algebra. This led to a decline in both course grades and test scores of high-skilled students, perhaps because the reform exposed such students to lower-skilled peers and less rigorous curricula (Allensworth, Nomi, Montgomery, & Lee, 2009; Nomi, 2012). California's 2008 decision to make algebra the benchmark test for eighth grade accountability purposes substantially increased eighth grade algebra enrollment, which in turn led to lower tenth grade test scores, particularly in larger school districts (Domina, 2014). Recent attempts by two districts in North Carolina to accelerate algebra to eighth grade have resulted in lowered course performance, particularly for the lowest-skilled students (Clotfelter, Ladd, & Vigdor, 2015). The targeted acceleration model studied here did not clearly lower test scores among the lowest performing students eligible for advancement and thus suggests one potential advantage over universal acceleration policies.[4] That these marginal students struggle to earn high grades in harder courses is a common theme across all such interventions. We nonetheless expect

[2] See Figure 33 of The National Center for Education Statistics' 2013 publication "The Nation's Report Card: Trends in Academic Progress 2012".

[3] Because WCPSS students outperform North Carolina's students on average, the marginal student affected by the policy was in roughly the 35th percentile of the statewide distribution.

[4] We believe there are two reasons we do not find the negative achievement effects seen in Clotfelter et al. (2015). First, the WCPSS intervention was targeted, so that marginal students were placed largely into classes with at least moderately-skilled peers, in contrast to the universal policies studied in that prior work, where low-skilled students may have been placed into classes largely populated by similarly low-skilled peers. Peer effects, as well as teachersâôûôû abilities to tailor classes to a more appropriately skilled set of students, may thus drive some of these differences. Second, because WCPSS is higher performing than the districts studied in that prior work, the marginal student here is closer to the middle of the distribution in that work. This may also explain why we do not see negative effects, given that the policy we study excludes from acceleration students with skills so low they are not predicted to succeed in Algebra I.

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