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How schools structure opportunity: The role of curriculum and placement in math attainment

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ABSTRACT

Most of the research on math attainment focuses on whether students begin the 9th grade in algebra 1, geometry, or algebra 2, and how that affects their subsequent progression through math sequences. While providing valuable insights, this focus on vertical differentiation among math courses fails to consider the horizontal differentiation existing at the same math level (e.g., remedial, general, and honors versions of the same course). This study uses statewide longitudinal administrative transcript data to examine the consequences of horizontal differentiation in algebra 1, the most common ninth grade math course. Analyses reveal that many students were placed into remedial or honors algebra 1 despite not having corresponding low or high eighth grade math standardized test scores. The consequences of placement into less rigorous math courses were very difficult to overcome, even accounting for eighth grade test scores and ninth grade achievement. In addition, school algebra 1 curriculum was associated with attainment beyond students' own course placement. These findings offer important insights into how school curricula structure opportunities, with implications for both theory and practice.

1. Introduction

Schools play a role in sorting and selecting students (Sorokin, 1959). American high schools have largely shifted from sorting students into rigid curricular tracks to allowing more flexible curricular choices; however, curriculum differentiation is ubiquitous (Lucas, 1999). Differentiation is particularly prominent in math. The sequential nature of math curriculum means that high school students vertically progress on a path that typically begins with algebra 1 and continues through algebra 2, ending with precalculus and calculus. Math courses are also often horizontally differentiated into more and less rigorous versions of the same course (e.g., remedial, general or honors), thus distributing students across different points through which they can progress through vertical math sequences.

Algebra 1 is a "gateway" to higher mathematics attainment with important long-term consequences (National Mathematics Advisory Panel, 2008) and an area of critical importance identified by Common Core State Standards, which have been adopted by a large majority of state education systems (Common Core State Standards, 2015). Students taking or completing algebra 1 upon entering high school could be considered at their last opportunity to be "college bound" with respect to their mathematics coursetaking. Ninth grade algebra 1 students have the opportunity to complete geometry in 10th grade, algebra 2 in 11th grade, and precalculus in 12th grade. This is a standard progression toward high attainment that allows students to complete at least algebra 2 for college access and precalculus for a more competitive profile (Adelman, 1999, 2003; Pelavin & Kane, 1990; Schiller & Hunt, 2011), including preparation for college math courses and prerequisites for STEM (science, technology, engineering, mathematics) majors (Tyson, Lee, Borman, & Hanson, 2007; Tyson, 2011). In addition to being a strong predictor of college entry and major, high school math coursetaking is related to college completion (Adelman, 2003, 2006) and employment income among those who attend college (National Mathematics Advisory Panel, 2008).

While ample research has examined how beginning the 9th grade in a specific math course affects subsequent educational success, much less attention has been dedicated to understanding the consequences of horizontal differentiation in algebra 1—the most common ninth grade math course—especially with respect to the variation in opportunity structures across schools. In Florida pub-

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lic schools, 9th grade algebra 1 students are placed into one of three different levels (remedial, general, or honors) based partly on their performance on the 8th grade standardized math test (Florida CPALMS, 2015). Moreover, that placement occurs within a specific curriculum – the combination of algebra 1 courses offered by the school – ranging from fully tracked schools that offer remedial, general, and honors algebra 1 to detracked schools that offer only general algebra 1. We examine how variation in student math *placement* and school math *curriculum* is related to student math *attainment* by the 12th grade for students entering high school at the different levels of academic preparation. Using student transcript data from the Florida Department of Education (FLDOE) PK-20 Education Data Warehouse (EDW) and school data from the National Center for Education Statistics (NCES) Common Core of Data (CCD), we illuminate ways in which schools help to structure opportunities and facilitate unequal math attainment as students progress through high school.

2. Literature review

2.1. The principles of tracking and course placement

"Tracking is an organizational practice whose aim is to facilitate instruction and to increase learning (Hallinan 1994b, p. 79)." In the past, high school students were sorted into general, vocational, or academic tracks. The current practice of tracking is more often tied to specific courses (e.g., remedial, general, and honors version of the same course), than to a coherent program of study. The theory of tracking rests on students of similar abilities being grouped together. The argument is that students will benefit most when they are placed in instructional contexts tailored to their ability levels. This is expected to ease the work for teachers and provide more beneficial learning environments for students. The homogeneity of differentiated curricula allows teachers to better fit their material to their students' needs rather than lowering the teaching standard to fit the median student (Barr & Dreeben, 1983; Gamoran, 2004; Oakes, 1992; Rosenbaum, 1999). Similarly, arguments made specifically for remedial coursework rest on the belief that lower ability students need to learn at their own pace and may become disengaged in more challenging classes in which the bar is raised to meet the needs of more prepared students (Allensworth, Nomi, Montgomery, & Lee, 2009).

The theory of tracking, and its benefits, rests on two overarching principles (cf. Hallinan, 1994b). The first is that students are grouped based on their ability. In other words, prior academic performance is expected to be the driving factor in course placement. However, research indicates that there is substantial heterogeneity in student ability within tracks, and that similar students are placed into different tracks within schools (Garet & DeLany, 1988; Kilgore, 1991; Oakes, 1985). This is in part because other student characteristics such as race and family background are related to course placement (Gamoran, 1992; Kelly, 2009; Mickelson, 2001; Riegle-Crumb & Grodsky, 2010). Heterogeneity can also be created by curricular decisions, such as whether a school offers specific courses, such as remedial or honors.

The second principle is that students in all tracks receive high quality instruction that facilitates their cognitive development. However, much of the research over the last several decades indicates that students placed in lower tracks do not receive high quality instruction and thus appear to lose ground academically in relation to their peers placed in higher tracks (Attewell & Domina, 2008; Hallinan, 1994b; Lucas, 1999; Oakes, 1985; Oakes, Gamoran, & Page, 1992). Even students who succeed in remedial courses have difficulty moving into higher-level courses if their placement resulted in missing content and learning experiences necessary for higher-level courses (Hallinan, 1987; Oakes, 1987). Rosenbaum (1976) described track mobility as a tournament in which students in higher tracks remain on pace for high attainment and students on lower tracks cannot win. Remedial courses then become a "losers bracket" participants enter based on prior preparation and cannot escape regardless of how much they win in terms of their achievement.

2.2. Consequences of course placement

As much as the practice of tracking deviates from theory, so do its consequences. The evidence implies that tracking is a highly consequential practice, with track placement being related to many educational outcomes, from test scores and grades to educational aspirations and college-going (see Kelly, 2007 for a review). Contrary to the proposition that students benefit most when placed in tracks that match their ability levels, research has demonstrated that all students benefit from enrolling in academically rigorous tracks and courses (e.g., Gamoran & Mare, 1989; Gamoran, 1987; Oakes, 1985). Although there is at least some evidence that the lowest ability students derive less benefit from taking college preparatory courses than students of average or high ability (Gamoran & Hannigan, 2000).

In addition to the general literature on tracking, a specific body of research has examined the progression of students through the high school math sequence. Depending on prior attainment, students start high school mathematics sequences with lower-level math and/or algebra 1, followed by geometry and algebra 2, and then moving into advanced math courses, ending with precalculus and calculus. Students can advance to the next math level only after having satisfactorily completed the previous course in the sequence, thus creating tight course trajectories. Most of the research on math coursework has focused on this vertical differentiation—in other words, the consequences of starting high school in geometry or algebra 2 instead of algebra 1 or a lower-level math. For example, Riegle-Crumb (2006) found that students who started high school math at the algebra 1 level or higher had higher math attainment and Kelly (2009) found the same for students who started high school at geometry. While providing valuable insights, these studies do not consider the horizontal differentiation of algebra 1 courses. Starting high school in remedial, general, or honors algebra 1 course may be just as consequential as is starting high school in algebra 1, geometry, or algebra 2.

2.3. Cumulative advantage

The notion of cumulative advantage offers a possible explanation for the long-term effects of course placement. Blau and Duncan's (1967) concept of cumulative disadvantage is an adaptation of early research on status attainment based on group membership rather than individual achievement. In their review of cumulative advantage research, DiPrete and Eirich (2006) explain that an advantage held by an individual or group accumulates over time meaning that the benefits of this advantage increase over time. In this respect, the Blau-Duncan approach can be understood as the negative or positive effects of long-term exposure to a treatment effect such as a poor or high quality school. A treatment effect such as placement in remedial, general, or honors algebra 1 courses within the same school could also have a negative or positive effect on math outcomes assuming there are differences in the quality of instruction across courses.

The concept of cumulative advantage is related to Merton's (1973, 1988) work on the "Matthew effect" in which he found that early career scientists who had developed a strong reputation gained more recognition for their work compared to scientists who did the same work but with a weaker reputation. Ninth