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# Dividing Opportunities: Tracking in High School Mathematics

## Introduction

Many states across the country already have or are in the process of increasing their high school graduation requirements. This is especially true in mathematics. For example, Michigan has recently changed the number of required mathematics courses from zero to four.

These changes are intended to – among other things – minimize the amount of variation in graduating students' mathematics opportunities. Much of this variation is the result of the pervasive use of high school tracking.

This report examines the extent of tracking in the 30 high schools that are part of PROM/SE. These schools represented over 14,000 seniors from 18 districts. Our results find that students in these schools typically follow numerous tracks and are thus offered different mathematics opportunities. Consequently, when these students leave high school, the amount and type of mathematics they have been exposed to vary widely.

## What is Tracking?

Tracking is the practice of assigning different students to different groups of courses. For many years, tracking consisted of three distinct groups, which, ostensibly, matched students' future educational and vocational plans: the college preparation track, the general track, and the vocational track. Tracks spanned multiple academic subjects, so that a student in the general track for math was also in the general track for English, science, and social studies.

Today, school-wide tracks are rarely overt aspects of school policy. Rigid curricular programs that neatly divide students into three distinct groups have largely dissolved (Lucas, 1999; Oakes, 1985). This does not mean, however, that schools do not track students – most do. Rather, instead of overarching curricular programs that keep students in the same track across subjects, schools now differentiate students *within* subjects. This implies that within mathematics, students take one of several groups of courses. Open any high school handbook and you will usually find a page – complete with arrows and circles – dedicated to displaying the particular courses in each group and the order in which these courses are taken. You will also surely find a more complex system than the simple, college, general, and vocational trichotomy.

In many ways then, general labels such as vocational or college preparatory do not adequately describe the large variation in the amount, type, or order of students' mathematics courses. It may thus be more appropriate to define a student's mathematics track as the particular sequence of courses he or she takes.

## What Does Research on Tracking Tell Us?

Tracking is not a whimsical phenomenon. Most schools and districts in the United States track students because they believe it optimizes students' achievement. Advocates of tracking argue that this type of curricular differentiation facilitates teaching and learning, as it matches students' ability level to the most suitable curriculum. Tracking theory contends that some students would struggle immensely in high-level curricula while a low-level curriculum would confine others.

Most research on secondary school tracking, however, has found that differentiating the mathematics curriculum tends to adversely impact students in low-level courses compared to their high-tracked peers. Students in low-tracked mathematics courses are less likely to expect to go to college, less likely to actually attend college even after controlling for students' post-secondary expectations, and have lower self-images (Alexander, Cook, & McDill, 1978; Alexander & Cook, 1982; Alexander & Eckland, 1975; Alexander & McDill, 1976; Oakes, 1985; Rosenbaum, 1980; Vanfossen, Jones, & Spade, 1987). Perhaps most salient, though, is that many studies have found that mathematics tracking tends to exacerbate achievement inequalities between high- and low-tracked students (Gamoran, 1987; Gamoran & Mare, 1989; Gamoran, Porter, Smithson, & White, 1997; Hallinan & Kubitschek, 1999; Hoffer, 1992; Ma, 2000; Schneider, Swanson, & Riegle-Crumb, 1998; Stevenson, Schiller, & Schneider, 1994).

## How Does Tracking Arise?

In order for multiple mathematics tracks to subsist in a school, the school must offer multiple mathematics courses. A school that offers four mathematics courses – one corresponding for each grade level – and requires all of its students to take these courses only offers one possible sequence of courses and thus one track. However, this is highly uncommon. Schools typically offer more than four mathematics courses – often many more – and thus allow students to choose from numerous possible course sequences. These sequences can, and often do, vary by the number of courses taken, the order in which courses are taken, and the types of course taken.

What about the schools taking part in PROM/SE? What types of mathematics courses do these schools offer? How many? How are students arranging these courses into distinct course sequences? Most importantly, what do the course sequences present in PROM/SE schools tell us about students' opportunities to learn? This report attempts to answer these questions.

## How Many Different Mathematics Courses do PROM/SE Schools Offer?

Using transcript data from over 14,000 seniors in 30 PROM/SE high schools across 18 districts, we calculated the number of distinct mathematics courses offered. Unless there were obvious misspellings or abbreviations that suggested two courses were the same, no further classification was done. Each new course title was therefore treated as a different course. Two courses were not considered to be the same unless they had the *exact* same title. This means that two courses such as "Geometry" and "Formal Geometry" were considered to be two different courses.

It is possible that "Formal Geometry" and "Geometry" or "Applied Algebra" and "Algebra I" represent the same curriculum. This is an assumption that we are not willing to make. Previous research has shown that the covered content in two courses with a similar title can vary wildly (Cogan, Schmidt, & Wiley, 2001). We therefore find it more prudent to assume that if schools choose to represent the general content they are teaching in a course (such as geometry or algebra) by different course titles, then it is most likely that the content is different, at least to some extent.

The number of mathematics courses offered in PROM/SE schools varied considerably. In all, we found 270 different mathematics course titles in the 30 PROM/SE schools. 39 of these titles focused on beginning mathematics; 11 of these titles focused on beginning algebra; 9 dealt with geometry; and 9 dealt with advanced algebra. We list some examples of these different course titles below:

- **Beginning Algebra Content**: Applied Algebra, Algebra I, Algebra I Honor, Introductory Algebra, First Year Fundamental Algebra
- **Geometry Content**: Elementary Geometry, Plane Geometry B, Geometry, Informal Geometry, Fundamental Geometry
- **Advanced Algebra Content**: Algebra II General, Enriched Algebra II, Integrated Algebra II, Advanced Algebra II, Essentials of Algebra II, Algebra II.

PROM/SE schools also offer an array of courses where content is considered to be below that of beginning algebra. It would be incorrect, however, to assume that these courses share a similar curricular focus. Indeed, the wide variation in these course titles suggests a wide variation in students' mathematics opportunities. These titles are listed below:

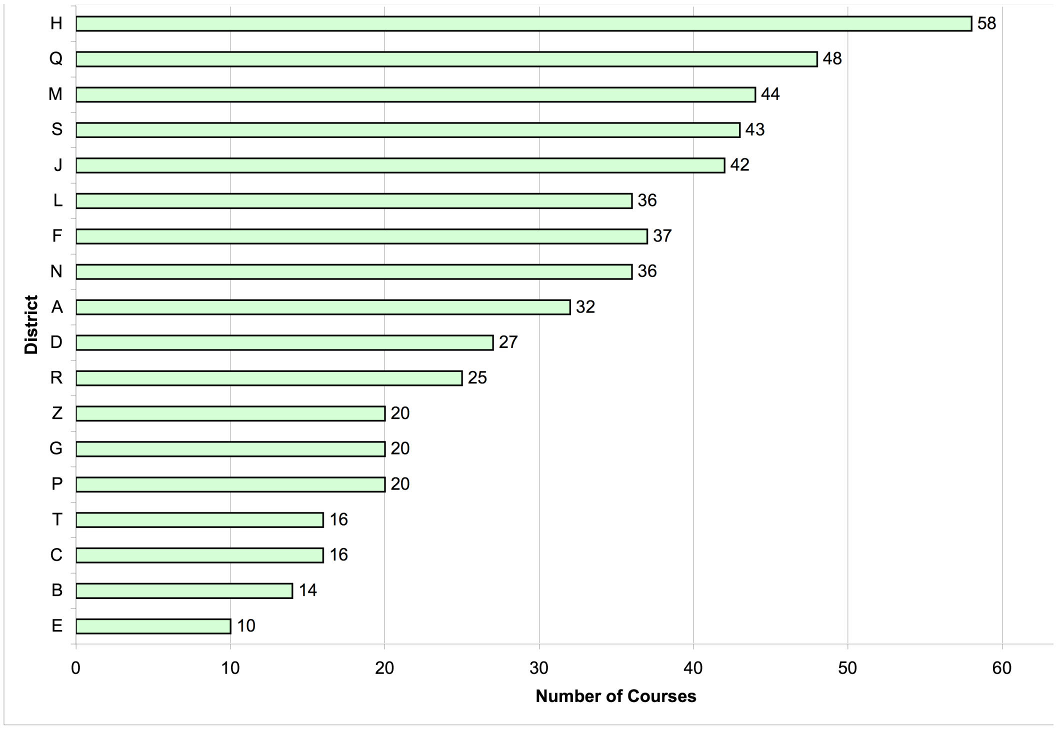
- **Below Beginning Algebra**: Fundamental Math, Technical Math, Transitional Math I, Contemporary Math I, Practical Math, Math Junior, Intervention Math I, Final Math Topics, Corrective Math, Alternative Math, Life Skills Math, Vocational Math.

## Do PROM/SE Schools Offer the Same Number of Mathematics Courses?

Although 270 is a striking number of different mathematics courses for only 30 schools, it does not follow that all PROM/SE schools offer such a copious amount. Figure 1 shows the number of mathematics courses offered in each district.[1] The number of courses ranges from a low of 10 to a high of 58. Most districts offer closer to 30 mathematics courses, but the variation between districts is compelling. If a district were to offer only one course for each mathematical content category (e.g. geometry, beginning algebra, pre-calculus, etc.) then there would typically be less than 10 courses offered. Only one district meets this standard (District E with 10 courses) while the others have two to six times more courses.

[1] We focus on the district rather than the school because the district sets curriculum policies. Of course, high schools in the same district – which was the case for several PROM/SE schools – may not offer the exact same number or types of mathematics courses. But an explicit district policy would have to allow this. Consequently, we found the variation among schools in the same district to be quite small.

Figure 1. Number of Mathematics Courses offered by District




## What Does the Proliferation of Course Titles Mean for Tracking?

As mentioned earlier, multiple tracks can only exist if a school or district offers multiple courses. This requirement is easily met in nearly all of the PROM/SE schools. This implies that students in each school can arrange the type, number, and order of their courses – and thus vary their exposure to mathematics – in numerous ways. Given this proliferation of high school mathematics courses, tracking can result from two somewhat distinct sources.

First, it occurs from the fact that there are many different available course types. Course types include algebra, geometry, advanced algebra, integrated mathematics, pre-calculus, calculus, statistics, and basic mathematics. How many and which particular broad categories of courses a student takes defines a broad-based definition of a track. For example, many high school students take an algebra course, followed by a geometry course, and end with an advanced algebra course. From this perspective of tracking, it makes no difference if the student took Algebra Honors or Formal Geometry, only that they took a course under the algebra or geometry umbrella.

When tracking is defined this way, there are relatively few course-sequences (i.e.

tracks). The most common are (each listed in the order that a student would take the class):

- basic math, algebra, geometry
- algebra, geometry, advanced algebra
- algebra, geometry, advanced algebra, pre-calculus
- geometry, advanced algebra, pre-calculus
- geometry, advanced algebra, pre-calculus, calculus
- algebra, geometry
- algebra, advanced algebra, geometry
- two, three, or four courses of integrated mathematics.

The second defining aspect of tracking derives from the fact that within a school, there are often multiple versions of the same course category. For example, a school may have more than one algebra course. It may offer Applied Algebra, Algebra I, Algebra I Honors, or others. The above results demonstrate that this phenomenon is common in PROM/SE schools, especially in the algebra and general mathematics categories.

The combination of these two conceptualizations of tracking generates an even greater chance for inequalities in mathematics opportunities. For example, two students in the same school may take substantively different courses (e.g. basic math, algebra, geometry, vs. geometry, advanced algebra, pre-calculus) *and* take different versions of these courses (e.g. Basic Algebra vs. Algebra I Honors). In all, the large variability between districts in the number and types of courses offered portends prodigious differences among high school seniors' exposure to mathematics.

### How Many Mathematics Courses Are PROM/SE Students Taking?

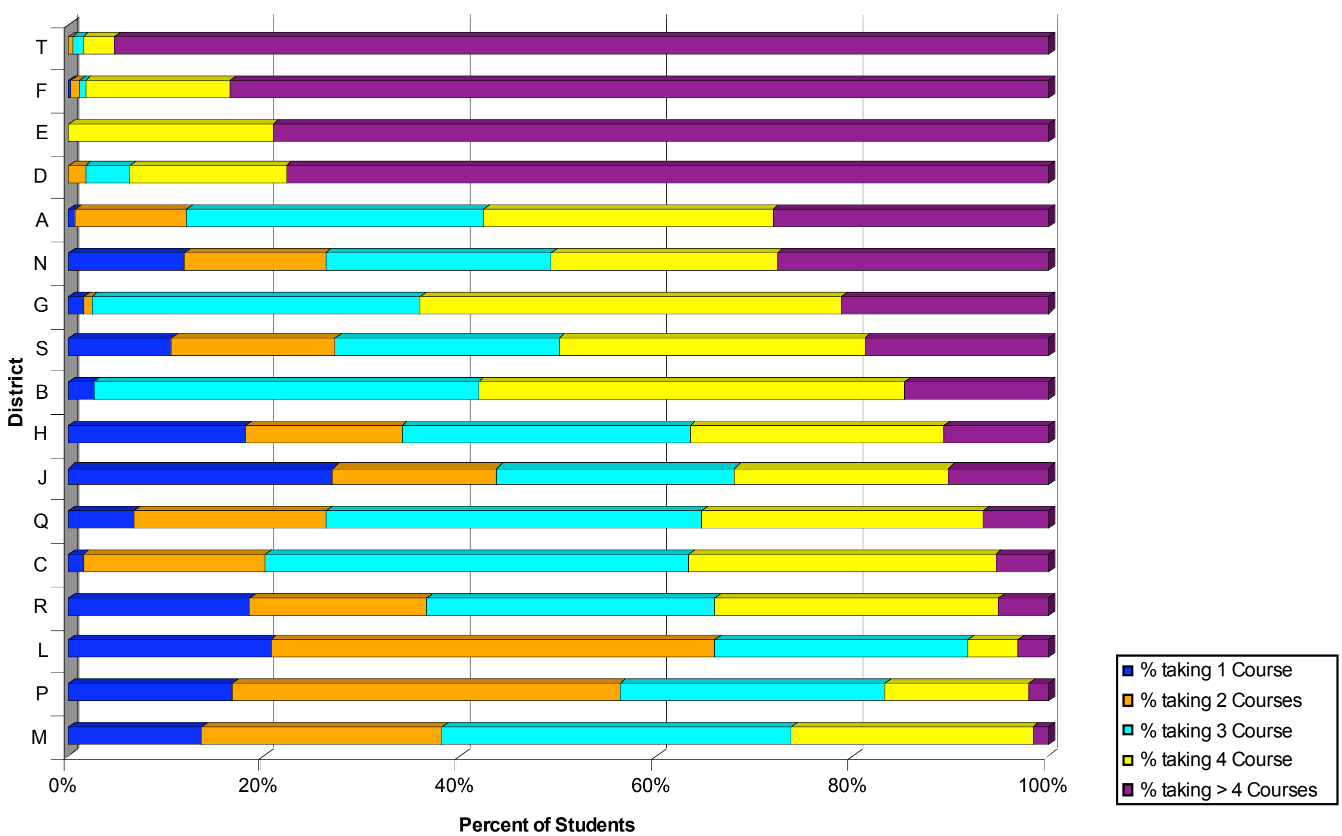
We have to this point focused entirely on the total number of courses that PROM/SE schools offer. We have seen large variation in both the number and the types of courses. The variation in actual courses taken, however, is not as large as it potentially could be. Many students take similar courses. The most popular courses were Algebra I, Geometry, and Algebra II. Each of these courses was taken by over 6,000 of the students – representing about 40% of all students. Nevertheless, over half of the students in PROM/SE schools did not take each of these particular courses. Variation in course-taking – and thus tracking – remains significant.

One particular way that students' mathematics course-taking varies is in the amount of courses they take. In order to examine this issue, we examined the number of mathematics courses taken by each of the 14,000 students in the 18 districts. Figure 2 shows the percent of students who take a particular number of courses by district.

What is perhaps most surprising about these results, is that in 2005, there was a sizeable percentage of students in each of several districts that took only one high school mathematics course. That percentage reached 25 in one district but was zero or virtually zero in others. On the other hand, in some districts nearly all students took 4 or more mathematics courses, whereas in others less than 20% of students did so. In all, there was considerable cross-district variation in the amount of mathematics courses students took.

Figure 2 also shows substantial within-district variation: many students in the same district took different amounts of mathematic courses. Several districts had students who took anywhere from one to four or more courses. Students in the same school therefore had considerably different mathematics opportunities.

Figure 2. Number of Mathematics Courses taken by High School Students by District



### How Many Course Sequences Are Present in PROM/SE Schools?

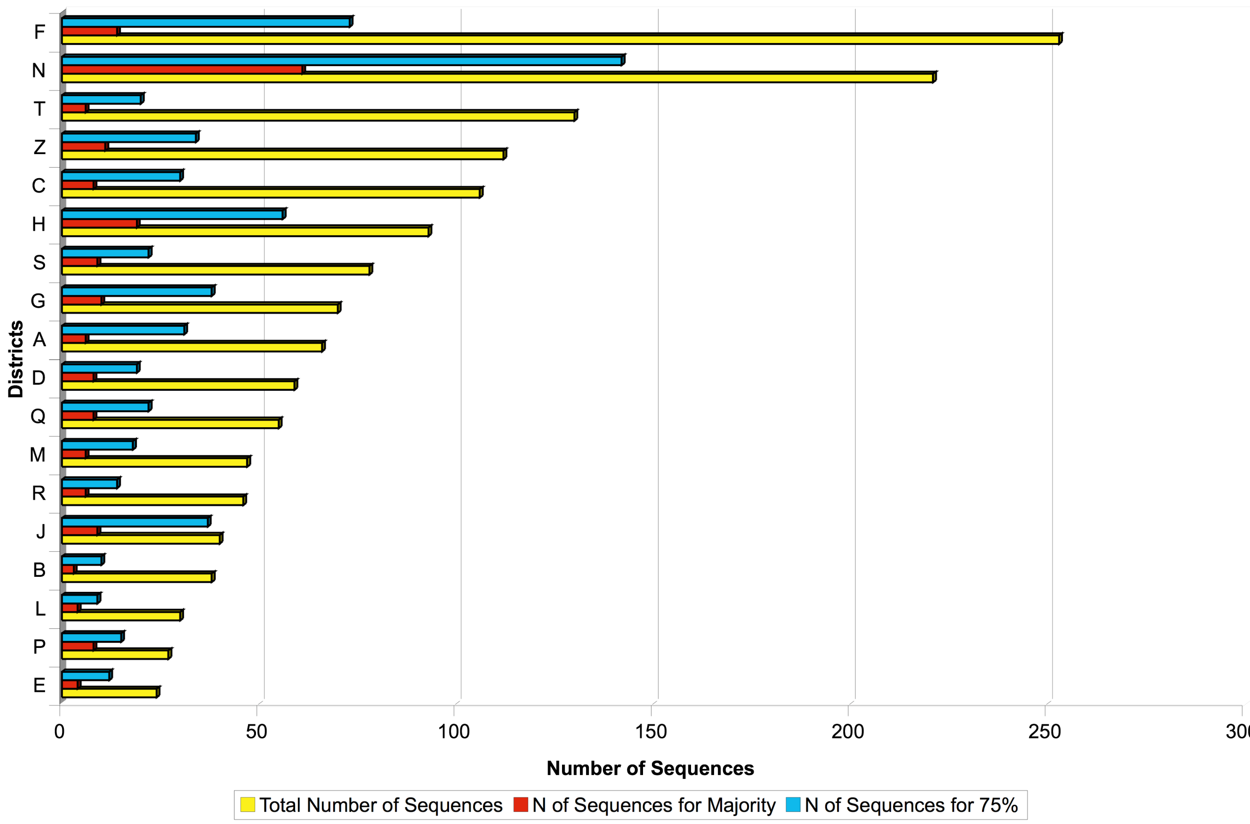
The large differences in the number of mathematics courses that students in PROM/SE districts take – both across districts and within districts – suggests that there are also large differences in students' course sequences (i.e. track). In order to examine this issue further, we recorded each of the 14,000 students' course selections and the order in which they took these courses. In other words, we recorded each student's mathematics course sequence.

In all, there were over 1500 such sequences. But like we saw with the total number of different courses offered, the number of sequences varies appreciably by district. Figure 3 shows the number of different course sequences present in each district. In some districts there were over 200 distinct course sequences while in others there were less than 30. Most districts, however, had closer to 60 sequences. Nevertheless, the variations in the number of course sequences are striking.

It is misleading, however, to think that each sequence is equally populated. Some sequences contain more students than others. Therefore, Figure 3 also shows the minimum amount of sequences needed to represent a majority of students' (i.e. more than 50 percent) and for three-fourths of students' course-taking behavior.

These percentages are particularly revealing: most students in each district belong to a relatively small number of sequences or tracks. In every district, less that one-third of the total course sequences were needed to account for a majority of students; in some districts less than one-sixth of the sequences were needed. For example, in the district with 253 total course sequences only 14 sequences were needed to account for a majority of students. Even to account for 75 percent of the students, "only" 73 sequences were needed.

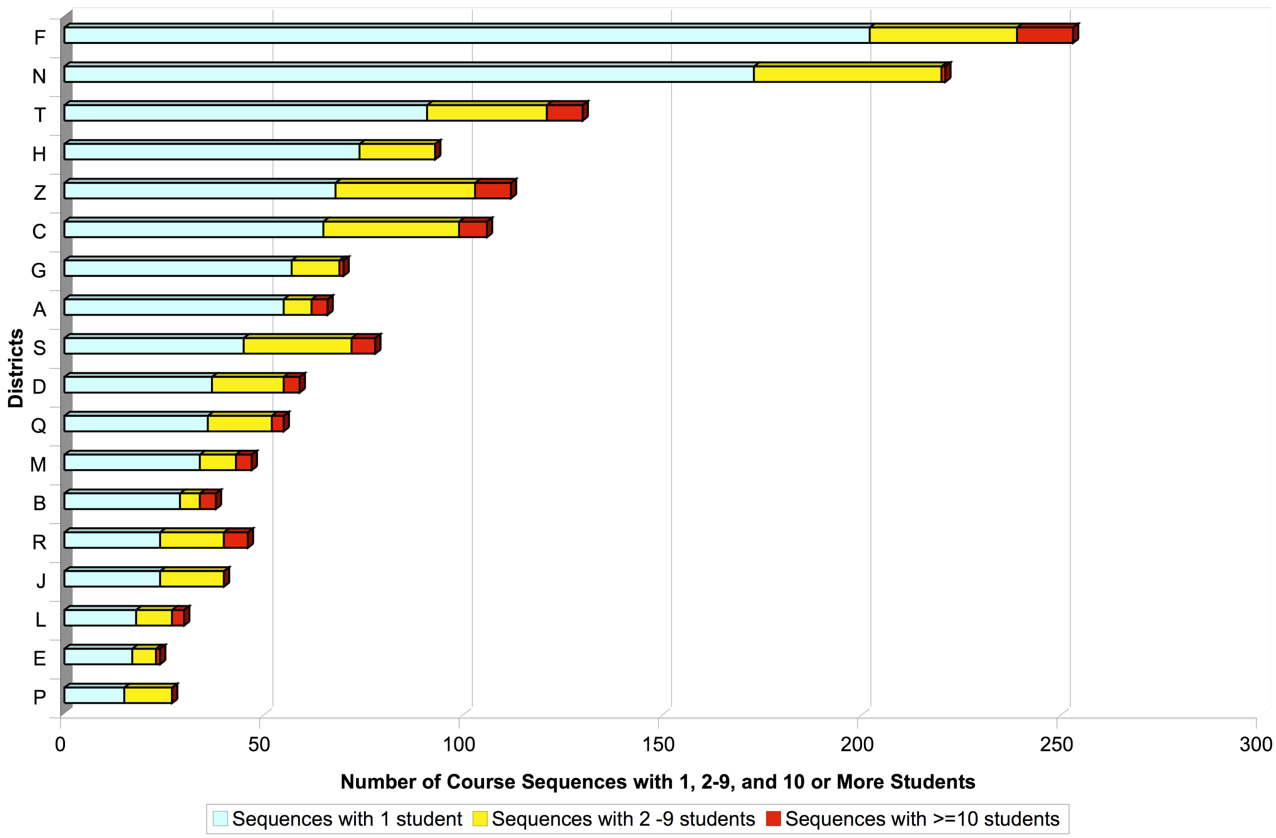
Figure 3. Number of Mathematics Course Sequences by District




In all, the number of sequences needed to account for the simple majority of students was less varied than the total number of sequences. With the exception of district N, which required 61 sequences, the remaining districts varied from 3 to 19. Although this variation is more reasonable, it is anything but insignificant. Moreover, the fact that 51 percent of students in each district are ensconced in substantially fewer sequences implies that the remaining 49 percent of students are sprinkled among various alternative sequences.

Figure 4 further examines this issue. Figure 4 shows the number of sequences populated by only one student, two to nine students, or greater than or equal to ten students. As expected, the number of sequences with only one student represented a large percentage of all sequences in every district. At the extreme, District F – which had a total of 253 distinct sequences – had 202 sequences (80 percent) that were unique to a single student.

Figure 4. Course Sequences with One or More Students by District




## Implications for Students' Mathematics Opportunities

This report has found several startling facts. Schools in PROM/SE offer an incredibly large number of distinct mathematics course titles. Although each district offers many different course-titles, there is substantial variation across districts. Many of these course titles are variations of broad curricular categories such as algebra or geometry. Nonetheless, it is unwise to assume that these variations are simply different names for the same course. Each course may present different curricular opportunities.

This large variation in the number and types of courses in PROM/SE schools portends the presence of tracking. Indeed, we found substantial differences in the number of courses students took – both within and across districts. Some students – a sizeable amount – only took one mathematics course while others took more than four. These differences translated into differences in the sequences of courses or tracks that define students' mathematics opportunity.

Students may have in common that they attend high school in the same district, but as they graduate there is little commonality in the type of mathematics to which they have been exposed. It is not that all high school students should take the same courses, but there should be a high degree of overlap across programs for most students.  This would result in a relatively small number of mathematics tracks – certainly not 100.

As it stands, there are substantial differences in the mathematics opportunities for students in different districts and students within the same district. These differences question one of education's most revered truisms: schools provide a level playing field. This report shows that as mathematics education varies so widely, and had so many tiers, that perhaps a more appropriate metaphor should be that schooling in America is played on a field laid out on the side of a mountain.

Promoting Rigorous Outcomes in Mathematics and Science Education (PROM/SE) is a comprehensive research and development effort to improve mathematics and science teaching and learning in grades K-12, based on assessment of students and teachers, improvement of standards and frameworks, and capacity-building with teachers and administrators.

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