Abstract Title Page

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Title: Variation in Content Coverage by Classroom Composition: An Analysis of Advanced Math Course Content

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Abstract Body

Background / Context:
One approach to reducing educational inequality is to give students equal access to opportunities to learn/educational inputs (Coleman, 1990), such as advanced courses in high school. Students who take advanced courses learn more than students in lower level courses (Gamoran, 1987; Gamoran & Hannigan, 2000; Bozick, Ingels, & Owings, 2008); therefore, providing equal access to advanced courses may reduce pervasive racial achievement gaps in the United States.

In the past 20 years, more and more students have enrolled in advanced math courses (National Science Board, 2008); this increase has the potential to provide more equal schooling experiences for students. Increased access to advanced math courses gives students increased learning opportunities and increases the likelihood that they will enroll in and complete college (Adelman, 1999). More specifically, math skill level is related to whether students will enter STEM occupations (Tai, Liu, Maltese, & Fan, 2006). Thus racial inequality in math ability has implications for continued racial differences in the STEM fields and occupational outcomes. Advanced math course taking may equalize racial entry into the STEM field. Indeed, when academic preparation, such as course taking, is taken into account, black males are more likely than white males to major in a physical science or engineering (Riegle-Crumb & King, 2010).

Yet, in practice, equal access to learning opportunities such as advanced courses does not guarantee equal opportunities in practice. Covay (2010) and Riegle-Crumb & Grodsky (2010) find that black students and white students do not build the same math skills from taking advanced math courses, with black students benefiting less from advanced math courses than their white peers. Both studies use the Education Longitudinal Study (ELS), a large-scale, nationally representative data set. But ELS lacks important information on the instructional practices related to content breadth and depth in the high school math classroom. In this study, I will examine variation in both the breadth and depth of content coverage in advanced math classrooms as a possible explanation for why black students and white students have unequal returns from course taking.

In a study of Chicago elementary schools, Diamond (2007) finds that black students and students from low income families tend to receive less rigorous instruction than do white students and middle class students. One reason black students receive fewer returns from advanced math courses may be that they are exposed to less rigorous course content. I will test this hypothesis.

Though students may take courses with the same title, (e.g., “Pre-Calculus”), this does not mean that they are receiving the same opportunities to learn. Institutional theory would suggest that courses may be labeled with the same title in order to preserve schools’ legitimacy (Meyer & Rowan, 1978); however, the material presented to students may vary across schools and classrooms depending on what the teacher focuses on and how she presents the material (Sørensen, 1987; Diamond, 2007), because teachers may have different goals for instruction (Porter, 1991). Despite the appearance of equality of educational opportunities through course labels, there may be vast inequalities of opportunity in practice.

Instituting academic standards is not sufficient to reduce educational inequality in the classroom (Rowan, Correnti, Miller & Camburn, 2009). Though states provide instructional standards for the teachers, the standards do not ensure that all teachers are *implementing* the standards in the same manner (see, e.g., Porter, 1991; Sandholtz, Ogawa, & Scribner, 2004; Stecher, Hamilton, & Gonzalez, 2004; Spillane & Burch, 2006); teachers ultimately decide what is taught in the classroom (Porter, 2002). Classroom settings are dynamic systems that involve teachers responding to the needs and abilities of their students. Based on the classroom setting, teachers make thoughtful content decisions (Schwille et al., 1983).

In addition to examining racial differences in exposure to opportunities to learn through content coverage, it is essential that I place those opportunities within the setting of the school and the classroom. The localized classroom and school context influences how policies, such as content standards, are implemented (Diamond & Spillane, 2004). Compared to white students, black students attend schools with higher percentages of minority students (Berends, Lucas, & Penaloza, 2008). Past research shows that schools with higher percentages of minority students and students from low socioeconomic status families tend to have lower quality teachers as measured by education level, certification, and years of experience (Lankford, Loeb, & Wyckoff 2002; National Science Board 2008). New teachers tend to be less effective than more experienced teachers (Rivkin, Hanushek, & Kain, 2005). Newer, inexperienced teachers may not provide the same breadth or depth of content in their teaching, thus giving their students fewer opportunities to learn and thus fewer returns from taking advanced courses. Students in predominantly minority schools or classrooms may be exposed to different levels of content coverage than are their peers in predominantly white schools or classrooms.

Purpose / Objective / Research Question / Focus of Study:

We know that there is racial inequality in achievement returns from advanced math; however, we do not know why black students and white students taking the same level of math courses are not leaving with the same or comparable skill levels. To find out, I will examine variation in course coverage by the racial composition of the classroom. I hypothesize that content coverage varies by classroom composition, because teachers respond to the needs and abilities of their students and make adjustments to teaching. More specifically, I ask:

1. *Within advanced math courses with the same title, to what extent does content coverage breadth vary by classroom minority composition?*
2. *Within advanced math courses with the same title, to what extent does content coverage depth vary by classroom minority composition?*
3. *Within advanced math courses with the same title, to what extent do the topics covered vary by classroom minority composition?*

Population / Participants / Subjects:

My study will include classroom level information as reported by the teachers of high school advanced math courses: trigonometry, advanced math, and calculus. In addition, I will categorize classrooms by their racial minority composition: predominately minority, predominately white, and racially mixed classrooms.

Research Design:

To examine racial differences in advanced math course content, we need data that contains information about what is occurring in the classroom setting. Data sets with information about student course taking, such as ELS, lack measures of course content. However, the Survey of Enacted Curriculum (SEC) offers a detailed record of teacher-reported course content. This content—what the teacher actually teaches—is called the enacted curriculum (Porter, 2004). Using the SEC will allow me to closely examine systematic differences in content coverage by the racial composition of the classroom.

The SEC has two parts: Instructional Practices and Instructional Content. Teachers complete the survey for one target class. The Instructional Practices portion includes background information about the teacher and the class. The Instructional Content portion is a lengthy matrix that teachers fill out as they reflect the content they taught during the most recent school year.

The matrix includes three steps. In the first step, teachers indicate the topics that they covered in their target class, such as basic algebra, advanced algebra, geometric concepts, advanced geometry, statistics, analysis, trigonometry, and functions. The large topic groups are divided further in more specific subtopics; in the second step, teachers say how much time they spent on each subtopic. For example, under the topic of statistics, teachers are asked about subtopics such as measures of central tendency, measures of dispersion, correlation, and hypothesis testing. The third step asks teachers what they expect of their students for each topic taught, or, in other words, the expected cognitive demand. There are five levels of cognitive demand (memorize facts/definitions/formulas; perform procedures; demonstrate understanding of mathematical ideas; conjecture/generalize/prove; solve non-routine problems/make connections). Combining the information from the teachers in the three steps of the Instructional Content Portion provides a measure of math content coverage, allowing me to look at content breadth and depth.

The SEC database is housed at the Wisconsin Center for Education Research. The data that I will use is a convenience sample resulting from a variety of research projects. Researchers request to use the SEC for their research projects and recruit teachers based on their project designs. The survey results are then stored in a larger SEC database. Each year, about 10, 000 teachers across four subjects (math, science, English/language arts, and social studies) take the SEC. I will restrict my analytic sample to surveys from the Math SEC and from teachers who teach trigonometry, advanced math, and calculus (N=682).

There are other ways to collect the information I seek; for example, classroom observation and daily teacher logs can produce valid and reliable data on the enacted curriculum. But classroom observations are impractical on a large scale and do not capture the enacted curriculum for the year. Daily teacher logs collect data for the full year, but they are expensive and place a large demand on teachers. The SEC is less expensive for researchers and less burdensome for teachers (Blank, Porter, & Smithson, 2001). Smithson and Porter (1994) find that teacher surveys of the enacted curriculum are highly correlated with teacher logs of the enacted curriculum. In addition, Blank, Porter, and Smithson (2001) find that teacher surveys of the enacted math curriculum and student surveys of the enacted math curriculum are significantly and positive correlated, which is additional evidence that surveys of the enacted curriculum are valid.

Though the SEC contains detailed descriptions of content coverage, the data have limitations. First, I will not be able to generalize my results to advanced math courses across the nation because it is a convenience sample. Nonetheless, this study will provide important information we currently lack about disparities in content coverage. Second, the SEC lacks student level variables. While the lack of student data limits my ability to describe an individual student's experience, I will not be limited in my ability to describe the classroom setting and make an important contribution to the literature. Despite its limitations, the SEC has been used by researchers to answer important research questions such as the relationship between content coverage and student achievement (Gamoran et al., 1997), alignment of the intended, planned, and enacted curriculum (Kurz et al., 2009), and, most recently, alignment of the Common Core Standards to current state standards, assessments, and cross-national standards (Porter et al. forthcoming). The detailed data collected through the SEC allows researchers to see into math instruction in a thorough, cost-effective, valid, and reliable manner.

Data Collection and Analysis:

I will use ANOVAs to test the hypothesis that students in predominantly minority and mixed race classrooms receive significantly different content coverage in terms of topic coverage than do students in predominantly white classrooms. I will focus on three advanced math courses: trigonometry, advanced math, and calculus. I will use the teachers' responses to topic coverage to measure breadth of content coverage. Teachers who cover more topics have a larger breadth of coverage than do teachers who cover fewer topics. To measure depth of content coverage, I will use density of topic coverage per class. The more topics a teacher covers during a class, the less depth of coverage. Finally, I will examine the specific topics that teachers cover. Covay (2010) finds that advanced math courses help black students to develop their basic and lower level math skills, while white students in classes with the same titles are developing advanced math skills. I hypothesize that students in predominantly minority classrooms receive instruction on less advanced topics than do students in predominantly white classrooms. If teachers are focusing instruction on basic and lower level math skills in advanced math courses, this could explain why minority students are making gains in basic skills from taking advanced math classes. In future analysis, I will also compare level of cognitive demand as a measure of content depth.

Findings / Results:

In my preliminary results, I find that about 70% of advanced math classrooms are predominately white in racial composition, with 11-14% of advanced math classrooms being predominately minority (See Table 1). In terms of content breadth and depth, I find that teachers of trigonometry in predominately white (PW) classrooms cover significantly fewer topics than do teachers in racially mixed (RM) or predominately minority (PM) classrooms (See Table 2). Teachers of advanced math in PW and RM classrooms cover significant more topics than teachers in PM. In terms of depth, teachers of advanced math in PW and RM classrooms cover more topics per period compared to teachers in PM, which would suggest teachers in PW and RM cover topics with less depth. In general, teachers of advanced math courses in PM classrooms tend to spend more time on basic skills such as number sense compared to teachers in PW classrooms. In addition, in calculus courses teachers in PW spend significant more time on analysis than do teachers in PM.

Conclusions:

Overall, my study will provide much-needed insight into variation of classroom instruction in advanced math classrooms. If the advanced math content coverage varies by classroom setting, equality of educational opportunity may be an illusion, with disparate opportunities to learn in practice. While all students make gains from taking advanced math courses, the gains are uneven. Black students leave high school with fewer math skills than do their white peers, despite having taken advanced math courses. The math skills gap has important implications for the future diversity and robustness of STEM fields. Preliminarily, I find that teachers of predominately minority classrooms spend more time on lower level math skills compared to teachers in predominately white classrooms. Moreover, in calculus teachers of predominately minority classrooms spend less time on more advanced topics. In this study, I will improve our understanding of how the racial composition of the classroom setting functions to influence content coverage. Understanding why uneven courses returns may be occurring will help shape interventions that will address disparities in math skills and improve classroom functioning.

Appendices

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Appendix A. References

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Appendix B. Tables and Figures

Table 1. Percentage of Advanced Math Classes by Racial Composition				
	Predominately White Classrooms	Racial Mixed Classrooms	Predominately Minority Classrooms	Total
Trigonometry	72.05%	13.66%	14.29%	100%
Advanced Math	71.53%	17.08%	11.39%	100%
Calculus	70.94%	16.24%	12.82%	100%

Table 2. Means and Standard Deviations								
	All Classrooms		Predominately White Classrooms		Racial Mixed Classrooms		Predominately Minority Classrooms	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Breadth of Coverage								
Trigonometry	.392	.250	.346 [a,b]	.202	.539	.302	.482	.335
Advanced Math	.405	.257	.413 [b]	.253	.438 [b]	.279	.299	.228
Calculus	.302	.236	.265	.216	.393	.280	.393	.245
Depth of Coverage								
Trigonometry	1.32	.779	1.31	.738	1.43	.928	1.32	.898
Advanced Math	1.33	.826	1.36 [b]	.840	1.47 [b]	.823	.990	.656
Calculus	1.10	.797	1.06	.817	1.22	.670	1.17	.829

Note: [a] indicates that there is statistically significant difference ($p<.05$) compared to racial mixed classrooms; [b] indicates that there is a statistically significant difference ($p<.05$) compared to predominately minority classrooms

Table 3. Topics Covered in Trigonometry by Classroom Racial Composition								
	All Classrooms		Predominately White Classrooms		Racial Mixed Classrooms		Predominately Minority Classrooms	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number Sense	0.115	0.081	0.103[b]	0.074	0.129	0.104	0.172	0.071
Operations	0.049	0.076	0.043	0.065	0.065	0.063	0.067	0.129
Measurement	0.073	0.053	0.071	0.054	0.089	0.055	0.065	0.040
Consumer Applications	0.017	0.020	0.015[b]	0.019	0.020	0.019	0.028	0.022
Basic Algebra	0.154	0.087	0.151	0.090	0.147	0.087	0.182	0.064
Advanced Algebra	0.101	0.071	0.101	0.075	0.104	0.060	0.094	0.053
Geometric Concepts	0.069	0.053	0.072	0.055	0.072	0.054	0.048	0.025
Advanced Geometry	0.020	0.020	0.020	0.021	0.024	0.020	0.010	0.013
Data Displays	0.020	0.032	0.019	0.032	0.027	0.032	0.024	0.031
Statistics	0.018	0.028	0.017	0.029	0.026	0.031	0.019	0.022
Probability	0.019	0.038	0.019	0.041	0.024	0.031	0.011	0.015
Analysis	0.023	0.035	0.025	0.039	0.014	0.013	0.014	0.024
Trigonometry	0.164	0.101	0.176	0.107	0.132	0.075	0.121	0.063
Special Topics	0.011	0.017	0.011	0.018	0.012	0.015	0.012	0.014
Functions	0.119	0.064	0.118	0.063	0.116	0.073	0.134	0.063
Instructional Technology	0.036	0.027	0.037	0.029	0.038	0.023	0.030	0.014

Note: [a] indicates that there is statistically significant difference ($p<.05$) compared to racial mixed classrooms; [b] indicates that there is a statistically significant difference ($p<.05$) compared to predominately minority classrooms

Table 4. Topics Covered in Advanced Math by Classroom Racial Composition								
	All Classrooms		Predominately White Classrooms		Racial Mixed Classrooms		Predominately Minority Classrooms	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number Sense	0.100	0.103	0.091[b]	0.092	0.113	0.094	0.137	0.160
Operations	0.038	0.059	0.038	0.058	0.046	0.071	0.026	0.042
Measurement	0.047	0.051	0.045	0.050	0.055	0.056	0.050	0.050
Consumer Applications	0.019	0.020	0.017[b]	0.018	0.021	0.020	0.028	0.030
Basic Algebra	0.154	0.093	0.151	0.093	0.147	0.083	0.187	0.099
Advanced Algebra	0.136	0.080	0.138	0.081	0.134	0.085	0.127	0.066
Geometric Concepts	0.052	0.087	0.049	0.078	0.056	0.060	0.066	0.155
Advanced Geometry	0.019	0.025	0.020	0.027	0.019	0.022	0.014	0.021
Data Displays	0.040	0.059	0.039	0.058	0.038	0.046	0.049	0.084
Statistics	0.041	0.067	0.040	0.066	0.046	0.062	0.037	0.075
Probability	0.041	0.064	0.042	0.064	0.040	0.053	0.035	0.078
Analysis	0.035	0.040	0.038	0.043	0.031	0.026	0.025	0.035
Trigonometry	0.088	0.084	0.095	0.090	0.070	0.069	0.067	0.055
Special Topics	0.021	0.032	0.021	0.028	0.027	0.049	0.014	0.019
Functions	0.142	0.087	0.146	0.088	0.134	0.083	0.120	0.085
Instructional Technology	0.036	0.027	0.037	0.027	0.038	0.028	0.030	0.028

Note: [a] indicates that there is statistically significant difference ($p<.05$) compared to racial mixed classrooms; [b] indicates that there is a statistically significant difference ($p<.05$) compared to predominately minority classrooms

Table 5. Topics Covered in Calculus by Classroom Racial Composition								
	All Classrooms		Predominately White Classrooms		Racial Mixed Classrooms		Predominately Minority Classrooms	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number Sense	0.080	0.089	0.072[b]	0.076	0.072	0.073	0.136	0.141
Operations	0.043	0.128	0.020[b]	0.047	0.087	0.233	0.116	0.208
Measurement	0.088	0.070	0.086	0.066	0.089	0.064	0.101	0.098
Consumer Applications	0.013	0.018	0.011	0.014	0.016	0.014	0.020	0.033
Basic Algebra	0.107	0.088	0.104	0.091	0.113	0.074	0.116	0.089
Advanced Algebra	0.061	0.047	0.056	0.047	0.080	0.036	0.064	0.049
Geometric Concepts	0.043	0.051	0.041	0.054	0.044	0.033	0.050	0.055
Advanced Geometry	0.029	0.044	0.028	0.047	0.045	0.036	0.016	0.018
Data Displays	0.017	0.032	0.011[b]	0.020	0.027	0.026	0.044	0.063
Statistics	0.008	0.018	0.005	0.012	0.013	0.020	0.017	0.033
Probability	0.006	0.020	0.004	0.016	0.011	0.024	0.013	0.033
Analysis	0.260	0.208	0.296[b]	0.220	0.196	0.133	0.129	0.125
Trigonometry	0.057	0.070	0.062	0.078	0.060	0.043	0.029	0.034
Special Topics	0.008	0.016	0.007	0.016	0.012	0.016	0.012	0.018
Functions	0.131	0.089	0.126	0.078	0.141	0.085	0.151	0.147
Instructional Technology	0.061	0.061	0.068	0.068	0.043	0.030	0.044	0.043

Note: [a] indicates that there is statistically significant difference ($p<.05$) compared to racial mixed classrooms; [b] indicates that there is a statistically significant difference ($p<.05$) compared to predominately minority classrooms