Rev Black Polit Econ (2012) 39:389–402
DOI 10.1007/s12114-012-9139-1

For Colored Girls? Factors that Influence Teacher Recommendations into Advanced Courses for Black Girls

Shanyce L. Campbell

Published online: 22 June 2012

Abstract Given the lack of attention to Black girls' participation in STEM related courses, it remains unclear why this group participates at lower rates in STEM courses later in their academic careers (Hyde et al. 2008; Tocci and Engelhard 1991; Catsambis 1994). The purpose of this paper is to examine the extent to which teachers influence Black girls' opportunities along the math pipeline. The aim is to determine the role of Black girls' cognitive and non-cognitive behaviors on teachers' decisions to place them in advanced courses. Using nationally representative survey data, the findings indicate that Black girls' confidence in their ability to master skills taught math reduced the odds teacher recommendations to advanced courses. Additionally, teachers' expectations of the educational attainment of Black girls were related to the recommendation process. Overall, the findings suggest that subjective beliefs held by students and teachers critically influence Black girls' persistence along the math pipeline.

Keywords Black girls · Mathematics · Advanced courses · Course taking · Tracking · Teacher recommendations

Introduction

Growing national concerns currently exist regarding the economic prosperity and global competitiveness of the United States. In efforts to address these concerns, researchers, practitioners, educators and policymakers have begun to examine the underrepresentation of people of color and women in science, technology, engineering and mathematics (STEM) related careers. The underrepresentation begins early in the education process and continues into college and later occupations. For women of color, the intersectionality of race and gender magnifies the inequities in access to

S. L. Campbell (✉)
Department of Public Policy, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA
e-mail: scampbell@unc.edu

math and science. According to the National Science Foundation (2011), Black, Hispanic, and American Indian women comprise 3 % of the science and engineering workforce. Despite steady increases in undergraduate degrees earned by Black women, only 7 % major in STEM-related fields (U.S. Department of Education, National Center for Education Statistics, NPSAS 2008; Sharpe and Swinton 2012).

Understanding the mechanisms that influence Black girls' participation is crucial if we are to develop ways to increase and sustain their participation in STEM courses, majors, and careers. Within the K-12 education, teachers are the most influential contributors to student learning. With approximately 8 million of Black girls in schools across the United States, teachers have a significant role in assuring that these students obtain the knowledge and skills necessary to participate in STEM careers (US Census 2010). Given the lack of attention to Black girls' participation in STEM related courses, it is unclear why this group participates at lower rates in STEM courses later in their academic careers (Hyde et al. 2008; Tocci and Engelhard 1991; Catsambis 1994). The purpose of this paper is to examine the extent to which teachers influence Black girls' opportunities along the math pipeline. The aim is to determine the role of Black girls' cognitive and non-cognitive behaviors on teachers' decisions to place them in advanced courses.

In the next section, I begin by discussing access and placement into advanced curriculum especially, mathematics. I then turn to the theoretical framework that aid in understanding the key inputs that maximize STEM participation. The analyses, which draw from the Education Longitudinal Study of 2002 (hereafter ELS), assess the degree to which cognitive and non-cognitive factors of Black girls' influence teachers' advanced course recommendations. I conclude by discussing policies implications that may aid in increasing Black girls' participation in STEM related courses.

Access to advanced curriculum

A rigorous curriculum has the ability to promote higher-order thinking, engage students, reduce discipline problems and builds students' capacity to learn. Rigorous curricula refer to the breadth of courses taken as well as the intellectual difficulty of content within a subject matter (Attewell and Domina 2008). At the secondary level, this type of curriculum tends to be reserved for honors, Advanced Placement (AP) or International Baccalaureate (IB) courses. However, representation in advanced courses is significantly lower among non-Asian students of color, because of an organizational practice known as tracking or racialized tracking (Diette 2012). Tracking involves the division of students into categories based on perceived ability, teacher recommendation, prior academic achievement, interest, and course availability. In schools that practice tracking, classes are often differentiated by the level of content rigor and type of instruction (Hallinan 1994; Watanabe 2008; Oakes 2005; Mickelson 2001).

In addressing racialized tracking in public schools across North Carolina, Darity et al. (2001) found a negative association between the racial composition of the school and enrollment into demanding courses for students of color. Results from the elementary and middle grades, showed that schools serving predominately students of color were more likely to enroll this group into academically and intellectually gifted (AIG) courses than schools serving a lower proportion of students of color. Consistent with other research, AIG identification in early grades correlated with future advanced course taking in middle and high school. At the secondary level, students of color were significantly underrepresented in AP courses; however, this disparity was not as pronounced in honors courses. Darity et al.'s analysis of the course self-selection process found that many low-tracked students questioned their academic capability and believed they belonged in lower-level courses. A possible explanation for this finding is the lack of exposure to challenging content and learning opportunities during earlier grades (Watanabe 2008; Rubin 2003; Yonezawa et al. 2002; Oakes 2005).

Course-taking decisions made by schools and students have serious long-term consequences. Using a matched sample of high school graduates, Attewell and Domina (2008) found that students who enrolled in several demanding courses were more likely to attend a 4-year college, attend a selective university, and graduate from college than students that enrolled in less rigorous courses. Scholars have long recognized that enrollment in advanced math courses in high school is shown to advantage students in the college admissions process and improves academic performance during college (Useem 1992; Choy et al. 2000; Geiser and Santelices 2004; Klopfenstein 2009).

Advanced mathematics placement process

The placement of students into courses is conditional on several school and individual student factors, such as counselor and teacher recommendations, school size, standardized test scores, and/or parental or student requests (Gamoran 1992; Ogbu 2003; Yonezawa and Jones 2006). Emphasis placed on each criterion varies by school. In an examination of math course placement, Useem (1992) found school size to be a contributor to the access of rigorous math courses. Smaller schools were often faced with resource constraints; therefore, unable to supply the number of course offerings that were demanded. In addition to school size, personnel such as school counselors played an essential role in the placement of Black girls into challenging courses.

Earlier studies on assignment decisions suggest that school counselors' discriminatory practices influence student assignments. Cicourel and Kitsuse (1963) found that students were assigned to tracked classrooms based on counselors' assessment of students' language, dress, behavior and perceived academic potential. Recent scholarship on counseling practices continues to reveal discriminatory practices; however, much of the research has shifted to logistical issues surrounding scheduling. Ogbu's (2003) study of school disengagement revealed that Black students believed counselors are reluctant to encourage or place them in honors or AP courses. The author also concluded that other student concerns, such as addressing behavior problems, overshadowed counseling students about the importance of advanced course taking. Similarly, Riehl and Pallas (1999) found that in high-poverty schools, counselors frequently enrolled Black students into classes without directly speaking with them due to time constraints and limited personnel. These studies illustrate how counselors' decisions consciously and unconsciously maintain educational inequalities among students.

Teacher recommendations are also a significant component of the course selection process (Gamoran 1992). Similar to counselors, teachers serve to either encourage or dissuade students from enrolling into advanced tracks (Yonezawa 2000). However, the literature on teacher recommendations into advanced courses is currently limited.

Much of the research, as it pertains to students of color and teacher relationships, focuses on the teacher's perceptions and expectations. Because students spend a significant portion of their day with teachers, these interactions are a key determinant of student success. A large majority of the research on teacher perceptions focuses primarily on white teachers, as this is the largest socio-demographic group in the teacher labor market. This body of literature on teacher perceptions concludes that white teachers hold more negative perceptions of Black students than of white students (Ferguson 2003; Tenenbaum and Ruck 2007; Oakes 2005; Ogbu 2003).

There is some literature that argues teachers show preferential treatment towards girls because of higher levels of attentiveness, social skills, self-discipline, and interest in school (Buchmann et al. 2008). However in a recent study, Francis (2012) found that teachers perceived Black girls as less attentive and more disruptive than their counterparts. These negative perceptions resulted in lower probabilities of honors course recommendations. Understanding differential teacher perceptions of Black girls is particularly complex because this group's behaviors and performance are racialized and gendered (Lim 2008).

Theoretical framework

Economists often approach the challenge of measuring student outcomes using an education production function (EPF). The EPF seeks to determine the causal path of student achievement and understand the key inputs that maximize student performance (Hanushek 2007). EPF assumes student achievement outputs directly relate to inputs. These inputs are determined by the research question of interest and exhibit items that are either under the control of policymakers, such as curriculum, teachers, schools and peer composition as well as factors not under policymakers control, such as innate ability, family background and neighborhood effects. More importantly, the educational process is cumulative in nature—past inputs effect current achievement.

The typical EPF is modeled as:

$$A_{ikt} = \beta + \delta A_{ikt-1} + \alpha S_{ikt} + \lambda F_{ikt} + \varepsilon_{ikt}$$

where A_{ikt} is the achievement of student i, in school k, in time t; $A_{ikt\text{-}1}$ is the prior achievement of student i; S_{ikt} is a vector of school inputs; F_{ikt} is a vector of family inputs and ε_{ikt} is the random error.

In the present model student achievement is measured by advanced course recommendation and prior achievement is measured using the student's math motivation and interest.

Methods

Data

Public use base year surveys from the Education Longitudinal Study of 2002 (ELS:2002) are used in this study to examine factors that influence advanced course recommendations.

ELS:2002, sponsored by the National Center for Education Statistics, offers a nationally representative sample of approximately 15,362 sophomores in public and private high schools across the United States. The baseline data is a part of a larger data collection effort to provide trend information regarding the postsecondary education, labor market participation and family formations. ELS:2002 is a compilation of student; parent; teacher; school administrators; and library media specialists surveys; however, students are the primary unit of analysis.

The student surveys provide information on student socio-demographic and educational characteristics; school experiences; extracurricular and sports participation; use of time; standardized test scores; values; and expectations. The teacher questionnaire collected provides information about teachers' background and student evaluations. School administrator data focus on school, student and teacher staffing characteristics, school policies, curricular programs, use of technology, and school governance and climate. In this study, the data is restricted to Black girls attending both public and private high schools.

Measures

Table 1 presents the descriptive statistics for the variables used in the analysis, separated in four categories: school-level inputs, peer inputs, family inputs, and student inputs. The outcome variable used in this paper is based on the following question from the ELS:2002 teacher questionnaire: "Have you recommended this student for academic honors, advanced placement or honors classes?" This question is asked of each student's math teacher.

School Inputs School inputs include socio-demographic factors, course taking policies, school resources, and teacher factors. School Demographics: School size is broken down into three groups: small schools (1–999 students), medium sized schools (1,000–1,999 students), and large schools (2000+ students). It is expected that larger schools offer more opportunities for Black girls to participate in advanced math courses than smaller sized schools. The socioeconomic status of the school is measured by the percent of 10th graders who received free or reduced lunch, which is divided into three classifications: less than 20 %, between 21 % and 50 % and greater than 50 %. Course Taking Policies: This variable measures school administrators' response to whether students are given the freedom to select their career majors and/or pathways, which is intended to provide upward track mobility. School Resources: The number of counselors provides a measure of school resources that may affect course assignment. In many cases, when schools face budgetary problems, counseling positions that are one of the key areas schools reduce their costs (Griffin and Farris 2010). Teacher Factors: Three categories are presented for teacher factors: socio-demographic characteristics, expectations and perceptions. Teachers' race, ethnicity, gender and years of experience serve as the socio-demographic characteristics used in this study. Years of teaching experience are squared to capture non-linearities in experience. Teacher expectations are measured using two questions: the beliefs teachers hold regarding the highest level of educational attainment they expect Black girls to achieve and whether teachers believed people could learn to be good at math. Teacher perceptions are measured based on responses to two related

Table 1 Descriptive statistics

Variable Description	Mean
Teacher Recommendation, 1 = Yes	0.115
Small School, 1–999 students	0.369
Med-Size School, 1000–1999 students	0.474
Large School, 2000+ students	0.156
Free and Reduced Lunch, <20 %	0.396
Free and Reduced Lunch, 21–50 %	0.305
Free and Reduced Lunch, >51 %	0.299
No Self Selection Track	0.162
Some Self Selection Track	0.366
Self Selection Track	0.472
Number of Counselors	4.241 (−2.617)
Black Teacher	0.16
White Teacher	0.564
Hispanic Teacher	0.022
Other Race Teacher	0.035
Teacher's Gender, 1 = Male	0.456
Teacher's Years of Experience	15.219 (−10.85)
Educational Attainment - Less than High School	0.034
Educational Attainment - High School/GED	0.217
Educational Attainment - College	0.698
Educational Attainment - Graduate School	0.051
Most People Can Learn to be Good at Math	0.927
Student's Intellectual Ability Important to Success	0.808
Teacher's Attention Important to Student's Success	0.894
Friend Grades Not Important	0.086
Friend Grades Somewhat Important	0.26
Friend Grades Very Important	0.655
Friend College Not Important	0.08
Friend College Somewhat Important	0.241
Friend College Very Important	0.68
Math Test Score	29.891 (−9.681)
Reading Test Score	25.52 (−8.452)
Math is Fun	0.357
Hours on Math Homework	2.788 (−3.92)
Hours on Math Homework, squared	23.117 (−65.879)
Class Participation - Never	0.514
Class Participation - Rarely	0.271
Class Participation - Less than Once/Week	0.216
Educational Attainment - Less than High School	0.007
Educational Attainment - High School Graduate	0.053
Educational Attainment - College	0.457
Educational Attainment - Graduate School	0.483

Table 1 (continued)

Variable Description	Mean
Mathematics is Important	0.56
Attends School for Skills Necessary for a Job	0.877
Studies to Increase Job Opportunities - Never	0.135
Studies to Increase Job Opportunities - Sometimes	0.336
Studies to Increase Job Opportunities - Often	0.528
Most People Can Learn to be Good at Math	0.845
Can Master the Skills being Taught in Math	0.533
Socioeconomic Status	−0.216 (−0.644)
Family Composition, 1 = Two person household	0.51
Most People Can Learn to be Good at Math	0.905
Parent Checks Homework - Never	0.324
Parent Checks Homework - Rarely	0.314
Parent Checks Homework - Often	0.362

N=893 for all variables except Teacher Recommendation. Teacher Recommendation has a sample size of 667. Standard deviations are in parentheses

statements: "when students are successful in achieving intended goals or objectives it is often attributed to the student's intellectual ability" and "when students are successful in achieving intended goals or objectives it is often attributed the teacher's attention to the unique interests and abilities of the student."

Peer Inputs These variables measure the importance of friends' grades and future college attendance. Peers have a significant influence on the academic decisions students make, especially for lower-tracked students (Oakes 1990; Tyson 2011). Unlike literature on peer effects, the concept of peers used in this study moves beyond the academic ability of classroom peers to address a more influential relationship—the academic orientation of the student's actual friends.

Family Inputs Family inputs include socioeconomic status, family composition and parental perceptions and expectations. Socioeconomic status is a composite of mother, father or guardian's education; family income; and mother, father or guardian's occupation. Family Composition: Family composition is a binary variable to determine whether the student lives in a two-person or single person household. Parental Perceptions and Expectations: These concepts are measured by how often parents check students' homework and their perceptions that people can learn to be good at math.

Student-Level Inputs Student characteristics of interest are cognitive ability and math affect. Cognitive ability is measured by performance on the math and reading standardized tests. These tests are criterion-referenced and are intended to represent what students know, not how students' performed relative to their peers. There were a total of 73 questions given on the base year math test and 51 questions on the reading test. Affect is measured using four domains: interest, aspiration, perceived usefulness, and confidence in math. These domains are consistent with prior research on the math pipeline (Catsambis 1994; Oakes 1990). Interest: Black girls' interest in math is determined using a variety of variables including, their belief that math is fun, hours spent on math homework and the level of class participation in math class. Hours spent on homework is squared to account for nonlinearities of additional hours spent on homework. Aspiration. Students' aspired level of educational attainment measures their educational aspirations. Perceived Usefulness. Utility is measured by the importance of math to students, their belief that school enables them to learn skills necessary for a job and the belief that students study to increase their job opportunities. Confidence: Confidence in math ability is assessed by the belief that people can learn to be good at math and the certainty they can master skills taught in math classes.

Analytic analysis

This study uses a logistic regression to estimate the probability of being recommended for advanced courses as a function of school, peer, family and individual student factors. The generalized logistic regression equation for estimating the probability of advanced course recommendation is:

$$TR_{ik} = \beta_0 + \delta S_{ik} + \alpha P_{ik} + \lambda F_{ik} + I_{ik} + \varepsilon_{ik}$$

Where TR_{ik} is an indicator for whether the teacher recommends student i for an advanced math course, in school k; S_{ik} is a vector of school inputs; P_{ik} is a vector of peer inputs; F_{ik} is a vector of family inputs; I_{ik} is a vector of student inputs; and ε_{ik} is the random error.

A large number of missing values was identified in ELS:2002 dataset. Missing data are a concern because it can threaten the validity of the findings due to efficacy, power, and parameter bias (Rose and Fraser 2008). To prevent possible bias and appropriately accounts for uncertainty in the estimates, the analysis employed multiple imputation (McKnight et al. 2007; Schafer and Graham 2002). This approach utilizes existing values from other variables in the model to replace missing values. In the study, ten datasets with imputed values were created, and combined to create a single dataset for analytic purposes. The outcome variable was included in the imputation as an auxiliary variable; however, the non-imputed outcome variable was used for the logistic analysis (von Hippel 2007). A sensitivity test was conducted running the imputation with and without the imputed values on the outcome variable and did not produce significant differences.

A large number of missing values were identified in ELS:2002 dataset. Missing data is a concern because it can threaten the validity of the findings due to efficacy, power, and parameter bias (Rose and Fraser 2008). Multiple imputation was employed to prevent possible bias in the estimates. Multiple imputation is shown to produce unbiased estimates and appropriately accounts for uncertainty (McKnight et al. 2007; Schafer and Graham 2002). This process utilizes existing values from other variables to substitute predicted values to create an imputed dataset. The overall imputation maintains the variability in the sample population by creating the imputed datasets, which are a function of the relationships that predict the missing values and the causes of missingness (Wayman 2003). In the study, ten datasets with imputed values were created and estimates were combined across datasets to produce a single dataset for analytic purposes. The outcome variable was included in the imputation as an auxiliary variable; however, the non-imputed outcome variable was used for the logistic analysis (von Hipple 2007). A sensitivity test was conducted running the imputation with and without the imputed values on the outcome variable and did not produce significant differences.

Results

Descriptive analysis

The descriptive statistics are presented in Table 1. At the school level, the majority of schools enrolled between 1,000 and 1,999 students and allowed students to select their track assignments. Consistent with the current demographics of teachers in the United States, the majority of the teachers in the sample were white women. Teachers also had approximately 15 years of experience teaching (SD≈11). In terms of teacher expectations, most teachers believed that Black girls would attend or graduate from college. The data show that 11.5 % of teachers recommended Black girls for advanced courses.

Results show while only 36 % of Black girls believed math was fun; 56 % believed math was important. Interestingly, 91 % of Black girls believed that people could learn to be good at math, whereas only 53 % believed that they could master skills taught in math class. This lower confidence in one's own ability may attribute to approximately 51 % of the students indicating they did not participate in math class.

The average test score in math was 29.9 (SD≈10, range 10.7–47.5) and 25.5 (SD≈8, range 12.9–65) in reading. While the students' test scores were low, their future educational aspirations were relatively high, which is consistent with current literature on educational aspirations of students of color (Mau and Bikos 2000). Forty-six percent believed they would attend or graduate from college, and 48 % believed they would go on to attend graduate or professional school. These percentages are higher than their teachers' educational expectations, where only 5 % believed these students would attend graduate or professional school.

Family composition was evenly distributed in the sample, with 51 % of students from two-person households. On average, the sample population of Black girls is from low socioeconomic families (range −1.67 to 1.83).

Regression analysis

Table 2 presents logistic regression results on the likelihood of being recommended for honors or advanced courses by math teachers. Reading test performance had a small significant effect on the likelihood that teachers recommend Black girls or advanced courses, but math test scores did not predict a recommendation decisions. Interest in math is also a statistically significant factor contributing to the odds of teacher recommendation. Specifically, compared to never participating in class, students who participated every day were more likely to be recommended for honors or advanced courses. Interestingly, girls who were confident they could master skills taught in math classes had lower odds of teacher recommendations than girls who were not confident. It is unclear the mechanisms that contribute to this finding;

Table 2 Logistic regression results on teacher recommendation into advanced courses

Variables	Teacher Recommendation
Small School, 1–999 students	0.938** (0.448)
Large School, >2000 students	0.533 (0.053)
Free and Reduced Lunch, 21–50 %	0.527 (0.484)
Free and Reduced Lunch, >51 %	0.51 (0.517)
No Self Selection Track	−0.211 (0.439)
Some Self Selection Track	−0.445 (0.355)
Number of Counselors	−0.046 (0.091)
Black Teacher	0.095 (0.438)
Hispanic Teacher	0.069 (0.952)
Other Race Teacher	0.354 (0.771)
Teacher's Gender, 1 = male	−0.054 (0.317)
Teacher's Years of Experience, squared	0.001 (0.001)
Educational Attainment - Less than High School	−5.834 (5.892)
Educational Attainment - High School/GED	−2.316** (0.999)
Educational Attainment -Graduate School	1.679*** (0.433)
Most People Can Learn to be Good at Math	1.189 (0.839)
Student's Intellectual Ability Important to Success	0.061 (0.412)
Teacher's Attention Important to Student's Success	0.444 (0.505)
Friend Grades Not Important	0.874 (0.883)
Friend Grades Somewhat Important	0.438 (0.454)
Friend College Not Important	−0.609 (0.974)
Friend College Somewhat Important	−0.277 (0.445)
Math Test Score	0.037 (0.031)
Reading Test Score	0.048* (0.272)
General Track Enrollment	0.251 (0.376)
Vocational Track Enrollment	−0.533 (0.652)
Math is Fun	0.006 (0.396)
Hours on Math Homework, squared	−0.003 (0.003)
Class Participation - Rarely	0.322 (0.379)
Class Participation - Less than Once/Week	0.941** (0.441)
Educational Attainment - Less than High School	−1.667 (6.469)
Educational Attainment - High School Graduate	0.842 (1.082)
Educational Attainment - Graduate School	0.175 (0.343)
Mathematics is Important	0.644 (0.439)
Attends School for Skills Necessary for a Job	0.218 (0.533)
Studies to Increase Job Opportunities - Never	−0.095 (0.649)
Studies to Increase Job Opportunities - Sometimes	0.055 (0.436)
Most People Can Learn to be Good at Math	−0.612 (0.458)
Can Master the Skills being Taught in Math	−0.939** (0.435)
SES	−0.041 (0.253)
Family Composition	0.39 (0.335)
Most People Can Learn to be Good at Math	−0.769 (0.508)

Table 2 (continued)

Variables	Teacher Recommendation
Parent Checks Homework - Never	−0.139 (0.416)
Parent Checks Homework - Rarely	−0.051 (0.366)

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

however, misinterpretations of students behaviors may be influencing this finding. For example, if Black girls routinely overwhelm teachers with questions to ensure their mastery, teachers could understand this to mean that the student does not fully understand the material and not yet ready to progress to more challenging courses.

Expectations teachers' hold about Black girls is also a significant contributor in recommendation decisions, even after controlling for achievement. Compared to expectations of college attendance, teachers that expected Black girls to complete high school were less likely to recommend honors or advanced courses. Compared to expectations of college attendance, teachers who expected students to continue on to graduate school were more likely to recommend Black girls for honors or advanced courses. These findings highlight the importance subjective factors are in the decision making process.

Another key factor was the size of the student population at schools. Consistent with earlier analysis, smaller schools offer better educational outcomes for Black girls (Cotton 1996, 2001; Howley Howley 1994; Raywid 1999). Students in smaller schools were more likely to be recommended for advanced courses than students in mid-sized schools. Unlike previous studies, family characteristics and peer inputs did not have a significant effect on the probability of teacher recommendations.

There are several limitations of this study that should be considered in further studies of Black girls' academic success. First, this study uses data from a single year and does not allow for trends or patterns to be examined over time. Because ELS is a longitudinal dataset, observing students' actual enrollment in advanced courses could be examined for both those recommended and not recommended. Second, prior achievement variables were not available to control for innate ability or prior achievement. Third, a more methodologically advanced technique such as hierarchical linear modeling may appropriately capture the nesting of students within classrooms and classrooms within schools. Fourth, it is unclear from the data whether the math teacher's recommendation was for higher-level math courses or any advanced course the school offered. Lastly, because this study focuses on secondary school it is unable to address the earlier points along the math pipeline, which are critical in improving STEM pipeline for Black girls.

Policy implications

The findings in the study highlight the importance of Black girls' cognitive and non-cognitive behaviors on teacher recommendations. As expected class participation has a positive effect on teachers' recommendation decisions, however, belief regarding mastering math skills negatively affects future assignments. In addition, teachers' beliefs about students' educational attainment affect recommendation decisions. Taken together, the findings from this study suggest that subjective beliefs held by students and teachers are critical factors that influence Black girls' math pipeline outcomes. Educational leaders, researchers and policymakers interested in advancing Black girls and women through the math pipeline should pay specific attention to student behaviors and how teachers interpret these behaviors as the risk of error affects STEM participation among this group.

Policies and programs have begun addressing the underrepresentation of students of color in STEM courses by increasing access to more challenging courses. One method has focused on eliminating tracking practices within schools. As an example, a Long Island district detracked middle and high schools as a way to increase the proportion of non-white and Asian students into rigorous curricula (Burris et al. 2006). The district provided additional supports for students previously enrolled in lower tracked courses to prevent de facto tracking such as mandated tutoring and regular counseling meetings (Welner and Burris 2006).

Because tracking occurs primarily at the secondary level, policies must also simultaneously address AIG programs at the primary level. In North Carolina, the Department of Public Instruction broadened the definition of AIG to increase the number of students of color in the program. However, as shown by Darity et al. (2001), this did not significantly increase students of color's representation in advanced courses. Therefore, eliminating AIG programs would ensure that all students are fully prepared for academically challenging coursework during middle and high school.

STEM education provides opportunities for Black girls to contribute to society through innovation and discovery. Effective practices and policies encouraging all students to participate in STEM education must be quickly developed and implemented in response to the rapid changes in the demographics of students. However, specific focus on the way in which STEM curriculum, majors, and careers are racialized and gendered must be discussed in order to increase the representation of Black girls and women in STEM fields.

Acknowledgment All errors are the responsibility of the author. I would like to thank Patrick Mason, Dania Francis, Rhonda V. Sharpe, Timothy Diette, Billye N. Rhodes and the participants at The Invisible Woman Conference for their helpful suggestions and comments.

References

Attewell P, Domina T. Raising the bar: curricular intensity and academic performance. Educ Eval Policy Anal. 2008;30(1):51–71.

Buchmann C, DiPrete TA, McDaniel A. Gender inequalities in education. Annu Rev Sociol. 2008;34 (1):319–37.

Burris CC, Heubert JP, Levin HM. Accelerating mathematics achievement using heterogeneous grouping. Am Educ Res J. 2006;43(1):137–54.

Catsambis S. The path to math: gender and racial-ethnic differences in mathematics participation from middle school to high school. Sociol Educ. 1994;67(3):199–215.

Choy SP, Horn LJ, Nunez A, Chen X. Transition to college: what helps at-risk students and students whose parents did not attend college. New Dir Institut Res. 2000;2000(107):4.

Cicourel AV, Kitsuse JI. The educational decision-makers. Indianapolis: Bobbs-Merrill; 1963.
Cotton K. School size, school climate, and student performance. Portland: Northwest Regional Education Laboratory; 1996.
Cotton K. New small learning communities findings from recent literature. [Portland OR] [Washington DC]: Northwest Regional Educational Laboratory. U.S. Dept. of Education Office of Educational Research and Improvement Educational Resources Information Center; 2001.
Darity W, Castellino D, Tyson K, Cobb C, McMillen B. Increasing opportunity to learn via access to rigorous courses and programs: One strategy for closing the achievement gap for at-risk and ethnic students. North Carolina Department of Public Instruction; 2001.
Diette T. Equal Resources? Access to Algebra Across Schools; 2012.
Ferguson RF. Teachers' perceptions and expectations and the Black-White test score gap. Urban Educ. 2003;38(4):460–507.
Francis D. Sugar and spice and everything nice?: Teacher perceptions of Black Girls in the Classroom; 2012.
Gamoran A. Is ability grouping equitable? Educ Leadersh. 1992;50(2):11.
Geiser S, Santelices V. The role of Advanced Placement and honors courses in college admissions. Center for Studies on Higher Education, Research and Occasional Paper Series, CSHE.4.04; 2004.
Griffin D, Farris AD. School counselors and collaboration: finding resources through community asset mapping. Prof Sch Couns. 2010;13(5):248–56.
Hallinan MT. Tracking: from theory to practice. Exchange. Sociol Educ. 1994;67(2):79–84.
Hanushek EA. Educational production functions. Palgrave Encyclopedia, 2007.
Howley C. The academic effectiveness of small-scale schooling. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service No. ED 372 897); 1994.
Hyde JS, Lindberg SM, Linn MC, Ellis AB, Williams CC. Gender similarities characterize math performance. Science. 2008;321:494–5.
Klopfenstein K. The link between advanced placement experience and early college success. South Econ J. 2009;75(3):873.
Lim JJH. Double jeopardy: the compounding effects of class and race in school mathematics. Equity Excell Educ. 2008;41(1):81–97.
Mau W, Bikos LH. Educational and vocational aspirations of minority and female students: a longitudinal study. J Couns Dev. 2000;78(2):186.
McKnight P, McKnight K, Sidani S, Figueredo A. Missing data: A gentle introduction. New York: The Guilford Press; 2007.
Mickelson RA. Subverting Swann: first- and second-generation segregation in the Charlotte-Mecklenburg schools. Am Educ Res J. 2001;38(2):215–52.
National Science Foundation, Division of Science Resources Statistics. 2011. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2011. Special Report NSF 11-309. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/.
Oakes J. Opportunities, achievement, and choice: women and students in science and mathematics. Rev Res Educ. 1990;16:153–222.
Oakes J. Keeping track: How schools structure inequality. 2nd ed. New Haven: Yale University Press; 2005.
Ogbu JU. Black American students in an affluent suburb: A study of academic disengagement. Mahwah: L. Erlbaum Associates; 2003.
Raywid MA. Current literature on small schools (ERIC Digest). Charleston: ERIC Clearinghouse on Rural Education and Small Schools; 1999.
Riehl C, Pallas AM. Rites and wrongs: institutional explanations for the student course-scheduling process in urban school. Am J Educ. 1999;107(2):116.
Rose RA, Fraser MW. A simplified framework for using multiple imputation in social work research. Soc Work Res. 2008;32(3):171–8.
Rubin BC. Unpacking detracking: when progressive pedagogy meets students' social worlds. Am Educ Res J. 2003;40(2):539–73.
Schafer JL, Graham JW. Missing data: our view of the state of the art. Psychol Methods. 2002;7(2):147–77.
Sharpe RV, Swinton O. Beyond antidotes: A quantitative examination of black women in academe; 2012.
Tenenbaum HR, Ruck MD. Are teachers' expectations different for racial than for European American students? A meta-analysis. J Educ Psychol. 2007;99(2):253–73.
Tocci CM, Engelhard Jr G. Achievement, parental support, and gender differences in attitudes toward mathematics. J Educ Res. 1991;84(5):280–6.
Tyson K. Integration interrupted: Tracking, Black students, and acting white after Brown. New York: Oxford University Press; 2011.

Useem EL. Getting on the fast track in mathematics: school organizational influences on math track assignment. Am J Educ. 1992;100(3):325.

U.S. Census Bureau, Current Population Survey. Enrollment status of the population 3 years old and over, by sex, age, race, Hispanic origin, Foreign born, and Foreign-born parentage; 2010.

U.S. Department of Education, National Center for Education Statistics. (2008). Quickstats [Chart showing major field of study with a focus on STEM fields by Gender and Race/ethnicity]. NPSAS:2008 Undergraduate Students. Retrieved from http://nces.ed.gov/datalab/quickstats/createtable.aspx.

von Hipple P. Regression with missing y's: an improved strategy for analyzing multiple imputed data. Sociol Methodol.; 2007:37.

Watanabe M. Tracking in the era of high stakes state accountability reform: case studies of classroom instruction in North Carolina. Teach Coll Rec. 2008;110(3):489–534.

Wayman J. Multiple imputation for missing data: What it is and how can I use it? Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL; 2003, April.

Welner K, Burris CC. Alternative approaches to the politics of detracking. Theor Pract. 2006;45(1):90–9.

Yonezawa S. Unpacking the black box of tracking decisions: critical tales of families navigating the course of placement process. In: Sanders MG, editor. Schooling students placed at risk: research, policy, practice in the education of poor and minority adolescents. Mahwah, NJ: Erlbaum; 2000; p. 109–140.

Yonezawa SS, Jones M. Students perspectives on tracking and detracking. Theor Pract. 2006;45(1):15–23.

Yonezawa S, Wells AS, Serna I. Choosing tracks: freedom of choice in detracking schools. Am Educ Res J. 2002;39(1):37–67.