

Math Anxiety, Achievement and Perceptions of Same-Ethnic Peers in Math Class

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Abstract

Using multiple linear regression analysis, this research explores racially and ethnically diverse students' feelings of math anxiety, how these beliefs shape their achievement in the subject, and whether students' math anxiety and performance in mathematics vary based on students' gender, race/ethnicity, and math level. Moreover, this study investigated the potential protective functions of perceiving a high proportion of same-ethnic peers in math class for buffering against the detrimental effects of high math anxiety on achievement. Results showed that when African American students reported a high level of math anxiety, their math grades were lower when they also perceived there to be a high proportion of same-ethnic peers in their math course compared to White students with similar levels of math anxiety and perceptions of same-ethnic peers. These results suggest that the effects of classroom same-ethnic representation for students' academic outcomes are more nuanced than labeling it as a "protective" factor. Other contextual factors may influence the relationship between math anxiety, perceived same-ethnic representation in math class, and achievement and should be explored in future research.

Keywords: math anxiety, math achievement, same-ethnic peers, same-racial peers, classroom demographics, classroom representation

1. Introduction

Racial achievement gaps are evident in mathematics across childhood and adolescence, where White and Asian students score significantly higher on national mathematics assessments than Black and Latinx students and have a higher likelihood of being considered proficient or advanced in mathematics (NCES, 2023). These achievement gaps also exist at the classroom level. Studies often show the performance of Black and Latinx students in their mathematics courses falls behind that of their White and Asian peers (Barbieri & Miller-Cotto, 2021; Else-Quest, Mineo, & Higgins, 2013). Success in mathematics can determine whether students pursue more advanced math courses, which subsequently impacts high school completion (Long, Conger, & Iatarola, 2012; Neild, 2009) and college enrollment (Long et al., 2012). There are no biological differences between racial/ethnic groups that account for such performance disparities in mathematics (Fish, 2013), which suggests these achievement gaps are not attributable to innate competence or proficiency, but rather are likely the result of psychological and environmental factors that encourage some students' success in math while impeding others'.

Abundant research shows that the beliefs students hold about a subject have considerable implications for their achievement in and willingness to engage with the subject (e.g. Eccles & Wang, 2016; Jiang, Simpkins, & Eccles, 2020; Wigfield, Tonks, & Klauda, 2009). In particular, having negative beliefs about mathematics has the potential to hinder students' success in the subject (Barbieri & Miller-Cotto, 2021; Else-Quest et al., 2013; Jiang et al., 2020) and reduce their likelihood of future engagement with mathematics in areas such as course taking (Reyes & Domina, 2017), college major selection (Jiang et al., 2020; Lazarides, Dicke, Rubach, & Eccles, 2020; Musu-Gillette, Wigfield, Harring, & Eccles, 2015), and entry into STEM-related occupations (Ahmed, 2018; Eccles & Wang, 2016; Lazarides et al., 2020).

Myriad studies find that math anxiety, or feelings of stress and anxiety when engaging with mathematical tasks and problems (Richardson & Suinn, 1972), has deleterious effects on students' experiences with and outcomes in mathematics (e.g. Barroso et al., 2021; Choe, Jenifer, Rozek, Berman, & Beilock, 2019; Li, Cho, Cosso, & Maeda,

2021; Orbach, Herzog, & Fritz, 2020). Students who feel anxious and stressed towards mathematics tend to avoid complex and rigorous mathematics tasks (Choe et al., 2019), experience difficulties with numerical reasoning and the manipulation of numbers (Vukovic, Kieffer, Bailey, & Harari, 2013), are less motivated and confident in their math competency (Li et al., 2021), and perform poorly on mathematics tasks and assessments (Lukowski et al., 2016; Orbach et al., 2020). Several contemporary meta-analyses have also documented a significant and robust relationship between math anxiety and mathematics performance (Barroso et al., 2021; Namkung, Peng, & Lin, 2019; Zhang, Zhao, & Kong, 2019).

The relationship between math anxiety and performance is often explained by deficiencies in the attention control system and cognitive resources that are critical for success in mathematics. It is believed that math anxiety impedes performance in math through a reduction in working memory, which is a short-term memory store involved with controlling, regulating, and maintaining information related to the task at hand (Engle, 2002). Ruminations and intrusive thoughts, such as those associated with high math anxiety, can interfere with working memory (Moran, 2016) and subsequently impede one's ability to successfully solve mathematics tasks (Suarez-Pellicioni, Nunez-Pena, & Colome, 2016). While the negative association between math anxiety and performance has been thoroughly examined, there is little research exploring how classroom demographics might relate to and interact with math anxiety in influencing achievement.

One important classroom demographic factor influencing the relationship between math anxiety and performance in mathematics might be students' racial/ethnic representation within their math courses. When I look around my classroom, for example, do I see other students who look "like me"? Research has shown that greater perceived racial/ethnic representation in educational contexts is associated with a number of beneficial outcomes, including greater feelings of belonging (Benner & Graham, 2009; Fuller-Rowell & Doan, 2010) and decreased perceptions of being discriminated against (Benner & Graham, 2013). Feeling connected and respected in school is generally related to perceiving a more positive school climate, which then can have downstream effects on academic achievement (Graham, Kogachi, & Morales-Chicas, 2022). Having same-racial/ethnic peers at school may be particularly advantageous for Black and Latinx students, as these students often experience more difficulties in school, such as being victimized by discrimination, and also undergo a more challenging transition to high school (Benner, 2011). In this sense, having greater perceptions of same-ethnic peers in school contexts appears to serve a protective function for some students against undesirable educational outcomes.

Limited research has shown that perceiving same racial/ethnic peers at school can also benefit students' math outcomes specifically. Graham and Morales-Chicas (2015) found that students have more positive beliefs about mathematics when they perceive there to be a higher proportion of same-ethnic peers in their math classrooms. Perceiving peers of the same race/ethnicity at school also appears to benefit students' math achievement. Specifically, Conway-Turner and colleagues (2020) demonstrated that as the percentage of same-ethnic peers at school increased, students' math scores also improved. However, the predictive utility of perceived racial/ethnic representation at the classroom level has not been thoroughly examined, and no studies to date have explored the interactive effects between math anxiety and perceptions of math class same-racial/ethnic representation in predicting math achievement.

1.2 Current Study

The purpose of the present research was to explore whether 9th grade students' math anxiety predicted their achievement in mathematics (as measured by their math grades), and whether this relationship was moderated by students' race/ethnicity and the proportion of same-ethnic peers they perceived to be in their math class. This research capitalized on a large, longitudinal, ethnically diverse sample of White, Asian, Black, and Latinx high school students in California who were surveyed as part of the UCLA High School Diversity Project. Participants provided information about their feelings of anxiety toward math, which math course they were currently enrolled in, the grades they received in math, and the proportion of same-ethnic peers they perceived to be in their math classes. Math class perceived same-ethnic representation was expected to moderate the relationship between math anxiety and achievement, such that perceiving a high proportion of same-ethnic peers will buffer against the negative effects of high math anxiety on math grades. Moreover, this relationship may be especially strong for students from racial/ethnic groups that are historically underrepresented in STEM fields, such as Black and Latinx students.

Examining 9th grade students is critical, as research shows that students' beliefs about math fluctuate most in the period between 7th to 10th grade, after which attitudes become more established and resistant to change (Ing &

Nylund-Gibson, 2017). Additionally, students' attitudes toward mathematics often become more negative as they age (Mata et al., 2012), especially during the transition from middle to high school (Ing & Nylund-Gibson, 2017). Thus, it is important for this research to target 9th grade students with the goal of identifying factors that may protect against or improve negative math beliefs, such as perceived classroom racial/ethnic representation, while attitudes are still flexible.

2. Method

2.1 Participants

This study utilized data from 3579 9th grade students from approximately 200 urban, ethnically diverse California high schools (51.6% female; ($M_{age} = 14.8$ yrs, $SD = 0.57$) who were participating in a longitudinal study of school diversity and psychosocial adjustment. Based on self-report data, the racial/ethnic composition of the initial sample was 33% Latinx, 24% White, 15% Asian, 11% African American, with the remaining 17% of participants identifying as Middle Eastern, Pacific Islander, American Indian, Filipino, South Asian, Multiethnic/Biracial, or Other. Only students who fell into the four major pan-ethnic groups (e.g. Latinx, White, Asian, African American) were included in the analytic sample, as other demographic groups were not large enough to allow for comparison across students' race/ethnicity. Similarly, students who were not enrolled in Algebra 1, Algebra 2, or Geometry were excluded from the analytic sample, as the number of students enrolled in these other courses was too small to be included in the analyses. The final analytic sample was comprised of 2726 students (53.7% female) with complete data. According to self-reports from participants, the racial/ethnic composition of the final sample was 40% Latinx, 29% White, 18% Asian, and 13% African American.

2.2 Procedure

The researchers recruited three consecutive yearly cohorts of 9th grade students for the study. The electronic survey was administered on lab-issued Apple iPads and took approximately 60 minutes to complete. Two graduate students distributed the iPads and instructions and were available to answer questions as students independently completed the survey. Written parent consent was obtained as well as participant assent forms prior to completing the surveys. Participants were given a \$10 cash honorarium after completing the survey.

2.3 Measures

2.3.1 Math Anxiety

Students' attitudes towards mathematics were captured by 18 items presented on 5-point Likert scales ranging from 1 = *no way!* To 5 = *for sure yes!*. Participants indicated their level of agreement with each item while considering their current math course. Based on an earlier factor analysis with a subset of the present sample (Graham & Morales-Chicas, 2015), four factors comprising distinct math attitudes and accounting for 61% of the variance in responses were identified. Among those factors was a 3-item measure (eigenvalue = 1.18): "Studying math makes me feel nervous," "I feel stressed out during math class," and "I try to say as little as possible in my math class"). These items formed our measure of *Math Anxiety* ($\alpha = 0.69$).

2.3.2 Math Achievement

Students' math achievement was measured by averaging students' Fall and Spring grades in their 9th grade math courses on a scale from 0.0 (i.e. receiving an F in the class) to 4.0 (i.e. receiving an A in the class). Grades were procured using school record data.

2.3.3 Perceived Same-Ethnic Representation in Math Class

To measure perceived same-ethnic representation in math class, participants answered the question "*How many students from your ethnic group are in your math class?*" on a 7-point Likert response scale ranging from 1 = *None or hardly any (less than 10%)* to 7 = *All or almost all (90-100%)* ($M = 3.32$, $SD = 1.59$). It was not feasible to objectively measure the demographics of specific classrooms, as participants attended a large number of high schools across the state. Nevertheless, utilizing subjective perceptions of classroom ethnic representation is still meaningful in its own right because it captures individuals' unique perceptions of their environment and context (Syed, Santos, Yoo, & Juang, 2018), which may be more related to their feelings of anxiety than objective measures.

2.3.4 Math Level

According to students' self-reports of their 9th grade math course, 38% of students were enrolled in Algebra or Algebra 1, 37% were enrolled in Geometry, 20% were enrolled in Algebra 2 or Advanced Algebra, and the

remaining 5% were enrolled in other courses such as Pre-Algebra, Calculus, and Trigonometry. Two levels of math were then created based on the responses, where students enrolled in *Algebra 1* ($n = 1101$) were classified as such, and students enrolled in Algebra 2 or Geometry were categorized as *Advanced Math* ($n = 1656$). The remaining 5% of students enrolled in other math courses were excluded from analyses, as responses could not be reliably categorized and the number of participants enrolled in such math courses was not large enough to allow for meaningful comparison.

2.3.5 Gender

Students self-reported their gender. Gender was coded dichotomously, with males assigned values of 0 and females assigned values of 1.

2.3.6 Parent Education

The parent or guardian with whom the student lived was asked to complete a questionnaire about their highest level of education. A score was computed with higher scores indicating higher educational attainment. This measure ranged from 0 to 5 (0 = elementary or junior high school to 5 = graduate degree), $M = 2.86$, $SD = 1.59$.

3. Results

3.1 Descriptive Analysis

A chi-square test of independence was run to examine the association between students' race/ethnicity and the math level in which they were enrolled. Students' race/ethnicity was significantly related to whether they were enrolled in *Algebra 1* or *Advanced Math* ($\chi^2(3, N = 2757) = 246.09, p < .001$). Black and Latinx students were more likely to be enrolled in *Algebra 1*, while White and Asian students were more likely to be enrolled in *Advanced Math* (i.e. Algebra 2 or Geometry) (see Table 1). A 4 (race/ethnicity) x 2 (gender) x 2 (math level) factorial ANOVA was conducted on math grades and math anxiety to better understand how these factors influence beliefs about and performance in mathematics. Means and standard deviations for math grades and math anxiety as a function of gender, race/ethnicity, and math level are shown in Table 2. Only findings significant at $p < .01$ are reported because of the large number of analyses testing main effects and interactions. There were significant main effects of gender on math anxiety and math grades, such that females reported higher feelings of anxiety toward math than males ($F(1, 2720) = 19.44, (p < .001)$), but females obtained higher grades in math than males ($F(1, 2720) = 17.56, p < .001$). There were also significant main effects of math level for math achievement: $F(1, 2720) = 100.06, p < .001$. Students enrolled in *Advanced Math* courses received higher grades in math than students enrolled in *Algebra 1*. Additionally, main effects of race/ethnicity for math achievement emerged: $F(1, 2720) = 47.04, p < .001$. White and Asian students significantly outperformed African American and Latinx students in their math courses. There were no statistically significant differences between the math grades of White and Asian students, or between African American and Latinx students. There were no 2- or 3-way interactions involving gender, math level, or race/ethnicity on either math anxiety or math grades.

Table 1. Participant Race/Ethnicity * Math Level Crosstabulation

		Participant Race/Ethnicity							
		Black		Asian		White		Latinx	
		n	%	n	%	n	%	n	%
Math Level	Algebra 1	200	55.6%	76	16.3%	239	29.8%	586	51.9%
	Advanced Math	160	44.4%	391	83.7%	562	70.2%	543	48.1%
	Total	360	100.0%	467	100.0%	801	100.0%	1129	100.0%

Table 2. Means and standard deviations of math anxiety and math grades as a function of race/ethnicity, gender, and math level

Measure	Math Grade		Math Anxiety		
	<i>M (SD)</i>		<i>M (SD)</i>		
	Alg. I	Adv	Alg. I	Adv	
African American	M	1.59 (1.15)	2.46 (1.12)	2.51 (0.80)	2.58 (0.99)
	F	2.08 (1.23)	2.61 (1.20)	2.57 (0.88)	2.60 (0.95)
Asian	M	2.53 (1.21)	2.96 (0.99)	2.58 (0.66)	2.58 (0.78)
	F	2.86 (1.10)	3.29 (0.87)	2.60 (0.82)	2.76 (0.76)
Latinx	M	1.91 (1.27)	2.52 (1.16)	2.51 (0.80)	2.52 (0.82)
	F	2.18 (1.22)	2.53 (1.19)	2.87 (0.95)	2.82 (0.88)
White	M	2.39 (1.00)	3.09 (0.84)	2.47 (0.79)	2.49 (0.79)
	F	2.59 (1.07)	3.24 (0.83)	2.75 (1.06)	2.75 (0.91)

Note. Alg I = Algebra 1, Adv = Advanced Level Math; M = Male, F = Female.

Correlations between the variables were also examined. Math grades were negatively correlated with math anxiety ($r = -0.35, p < .001$), such that having higher feelings of anxiety and stress towards math were associated with lower math grades. Math grades and math class perceived same-ethnic representation were not significantly related to one another ($r = -0.01, p = 0.882$). Similarly, math anxiety and perceived same-ethnic representation in math were not significantly correlated ($r = 0.02, p = 0.407$).

3.2 Multiple Linear Regression Analysis

Multiple linear regression analysis was used to examine whether students' math anxiety predicted their math grades, and whether this relationship was moderated by participants' race/ethnicity and perceptions of the proportion of same-ethnic peers in their math classes. The findings are displayed in Table 3. Assumptions of multiple linear regression were met, as residuals were normally distributed and there was no evidence indicating heteroscedasticity. Participants' gender, socioeconomic status (measured by parent education level), and math course level were controlled by including them as covariates in the regression model.

There was a significant main effect of math anxiety predicting math grades; students with high feelings of anxiety towards math received lower grades in mathematics than their peers with less anxiety ($B = -0.34, p < .001$). There was also a main effect of math class perceived same-ethnic representation, such that perceiving a larger proportion of same-ethnic peers in math class was associated with higher math grades ($B = 0.12, p < .01$). Additionally, there were main effects of gender ($B = 0.32, p < .001$) and parent education level ($B = 0.07, p < .001$) on math grades; females and students whose parents had higher education received higher grades in mathematics than males or students whose parents had lower levels of education. Math level also had a significant main effect on math grades ($B = 0.51, p < .001$). Students enrolled in *Advanced Math* courses received higher grades in their course than students enrolled in *Algebra 1*.

A significant 2-way interaction emerged between math anxiety and perceived same-ethnic representation in math class: contrary to the buffering hypothesis, high math anxiety was associated with lower math grades, especially for students who perceived a *high proportion* of same-ethnic peers in their mathematics course ($B = -0.05, p < .01$). 2- and 3-way interactions between math anxiety, race/ethnicity, and perceived same-ethnic representation were also examined within the regression model. Racial/ethnic groups were dummy coded before inclusion in the analyses; White students served as the reference group to which other racial/ethnic groups were compared. There was a significant 2-way interaction between math anxiety and race/ethnicity ($B = -0.16, p < .01$). Latinx students with high math anxiety received considerably lower grades in mathematics than their White peers with similarly high levels of math anxiety. There was also a significant 2-way interaction between perceived same-ethnic representation in math and students' racial/ethnic identification ($B = -0.13, p < .01$). African American students who perceived a large proportion of same-ethnic peers in their math classroom obtained lower grades in mathematics than White students who also perceived a high proportion of same-ethnic peers.

A significant 3-way interaction emerged between math anxiety, math class perceived same-ethnic representation,

and students' race/ethnicity ($B = -0.14, p < .01$). African American students who had high feelings of anxiety toward math and perceived a large proportion of same-ethnic peers in their math class received lower math grades than White students with similar levels of anxiety and perceptions of same-ethnic peers (see Figure 1). No other 2- or 3- way interactions were found to be significant between students' math anxiety, perceived same-ethnic math class representation, race/ethnicity, or math level in predicting math achievement.

Table 3. Regression Analyses Examining the Predictive Effects of Math Anxiety and the Moderating Effects of Perceived Same-Ethnic Representation on Math Grades

	Math Grades ($N = 2726$)	
	<i>b</i>	<i>SE</i>
Intercept	2.95***	0.19
Parent Education	0.07***	0.02
Math level (1 = Advanced)	0.51***	0.05
Ethnicity (0 = White)		
African American	-0.60***	0.07
Asian	0.117	0.07
Latinx	-0.38***	0.06
Sex (1 = Female)	0.32***	0.04
Math perceived same-ethnic representation (PSER)	0.12**	0.04
Math Anxiety	-0.34***	0.06
PSER x Math Anxiety	-0.05**	0.02
Math Anxiety x Race/Ethnicity (0 = White)		
African American	-0.16	0.08
Asian	0.08	0.09
Latinx	-0.16**	0.06
PSER x Race/Ethnicity (0 = White)		
African American	-0.13**	0.05
Asian	-0.07	0.05
Latinx	-0.07	0.04
Math Anxiety x PSER x Race/Ethnicity (0 = White)		
African American	-0.14**	0.05
Asian	-0.09	0.06
Latinx	-0.04	0.04

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

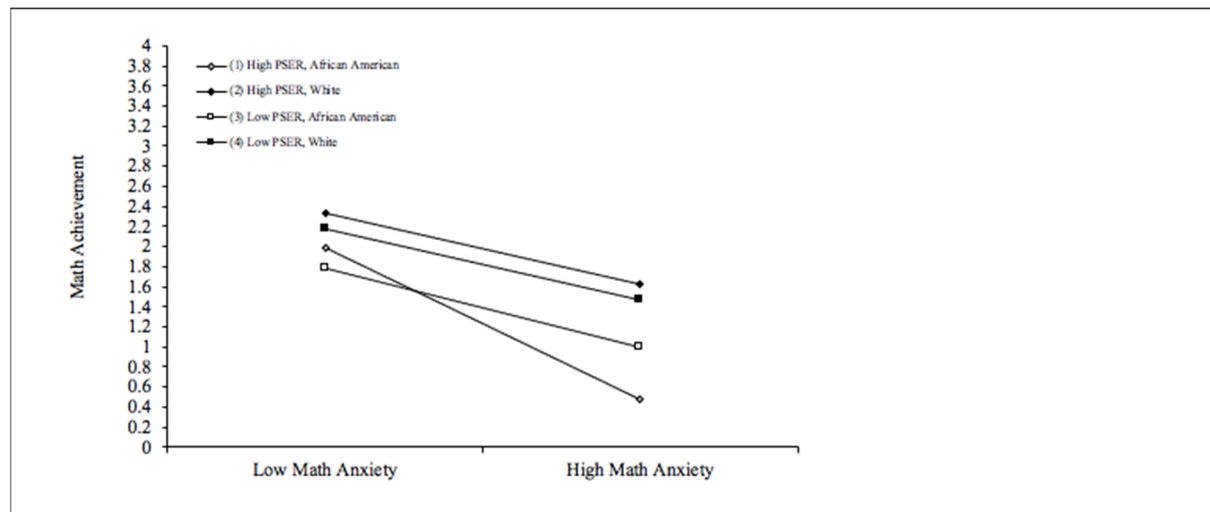


Figure 1. Three-way interaction between math anxiety, math class perceived same-ethnic representation, and race/ethnicity for math performance

4. Discussion

The findings of this research shed light on racially and ethnically diverse students' feelings of math anxiety, how these beliefs shape their achievement in the subject, and whether students' math anxiety and performance in mathematics vary based on students' gender, race/ethnicity, and math level. Moreover, this study investigated the potential protective functions of perceiving a high proportion of same-ethnic peers in math class for buffering against the detrimental effects of high math anxiety on achievement. The results of this study show that females received significantly higher math grades than their male peers, despite reporting greater feelings of anxiety toward the subject. These findings are consistent with the current body of literature on gender differences in math attitudes and achievement, which shows that females receive higher grades in math courses and assessments than males, but they also exhibit more negative beliefs about the subject than males (Else-Quest et al., 2013; Graham & Morales-Chicas, 2015).

The present study also revealed racial/ethnic differences in mathematics achievement. White and Asian students received considerably higher grades in their math courses than African American and Latinx students. Data from the National Science Foundation (2022) and the National Center for Education Statistics (NCES, 2023) support this finding, illustrating that White and Asian high school students receive higher scores on mathematics assessments compared to Black and Latinx students. Extensive research finds similar patterns of achievement in mathematics across racial/ethnic groups (e.g. Barbieri & Miller-Cotto, 2021; Else-Quest et al., 2013).

Results of this study highlight the importance of students' attitudes toward mathematics for their achievement in the subject. Students who exhibited higher levels of math anxiety received considerably lower grades in their math courses compared to their peers with less severe feelings of anxiety towards math. This finding is in line with a large body of research which shows that students who hold unfavorable perceptions of mathematics and feel stress in math-related contexts exhibit worse mathematics performance compared to students who perceive math in a more positive light (e.g. Barroso et al., 2021; Zhang et al., 2019).

4.1 Perceived Same-Ethnic Representation: Risk or Protective Factor?

The present research produced unexpected and interesting results regarding the moderating function of perceived same-ethnic representation in math class on the relationship between students' anxiety towards math and their actual performance. We expected students' increased perceptions of math class same-ethnic representation to minimize the effects of high math anxiety on achievement, however, the inverse pattern was obtained for African American students compared to White students. When African American students reported a high level of math anxiety, their math grades were lower when they also perceived there to be a high proportion of same-ethnic peers in their math course. Such results suggest that the effects of classroom same-ethnic representation on students' educational outcomes are more nuanced than simply regarding it as a "protective" factor. Other contextual factors may influence the relationship between math anxiety, perceived same-ethnic representation in math class, and

achievement.

Societal stereotypes about the mathematics abilities of students from different racial/ethnic groups may shed light on the complex relationship between math anxiety, math class same-ethnic representation, and math achievement. Empirical evidence documents the presence of stereotypes which insinuate African American and Latinx students are less skilled and competent in mathematics compared to White and Asian students (Evans, Copping, Rowley, & Kurtz-Costes, 2011; Ghavami & Peplau, 2012). These negative stereotypes about mathematics competency are often endorsed by students across adolescence (Evans et al., 2011; Ghavami & Peplau, 2012). For example, Evans and colleagues (2011) found that Black adolescents in 7th and 8th grade endorsed the belief that White students are more skilled and knowledgeable in mathematics than Black students. Individuals who identify with a group being negatively stereotyped and are within contexts where the stereotype is salient, such as math classrooms, often experience a self-evaluative threat which consequently undermines their performance on academic tasks (Spencer et al., 2016; Steele & Aronson 1995). Perceiving a high percentage of same-ethnic peers in math classrooms may reinforce stereotypes about inferior mathematics competency for students from racial/ethnic groups that are historically underrepresented in STEM.

Moreover, having a greater number of same-ethnic peers in one's classroom may exacerbate the effects of negative math beliefs on achievement for students in less competitive math courses. Despite participants being enrolled in schools selected for their racial/ethnic diversity, segregation at the classroom level was evident. African American and Latinx students were far more likely to be enrolled in Algebra 1 compared to their White and Asian peers, who were more likely to be in advanced (accelerated) math courses. These findings suggest that students' math level is not independent of the percentage of same-ethnic peers they perceive in their math classrooms. Thus, African American and Latinx students who are enrolled in less advanced math courses with many peers of the same race/ethnicity may have heightened awareness of the stereotype that students of their racial/ethnic background are not as proficient in mathematics as others, which can in turn impede their achievement in mathematics courses. Future research should explore whether students' endorsement of the stereotype that some racial/ethnic groups are more skilled in mathematics than others influences the relationship between their math anxiety, perceived math classroom same-ethnic representation, and math performance. Research should also test whether endorsement of such stereotypes varies based on students' race/ethnicity, math level, and classroom racial/ethnic composition.

Stereotypes and differential expectations from teachers may also explain the nuanced relationship between perceived same-ethnic representation in math and math achievement. Literature has shown that teachers have higher expectations of White and Asian students compared to African American and Latinx students with similar achievement levels (McKown & Weinstein, 2008). Additionally, teachers often have greater expectations of students with high achievement in math compared to lower achieving students (Hinnant, O'Brien, & Ghazarian, 2009). Considering that African American and Latinx students in the present sample received lower grades in their math courses and were more likely to be enrolled in less advanced math courses than their White and Asian peers, these students may be vulnerable to negative expectations and stereotypes from their teachers as a result of their race/ethnicity, math course enrollment, and performance in mathematics. In other words, teachers may be forming negative judgments of their students in math classrooms that are considered less advanced and contain a high percentage of students from racial/ethnic groups whose academic performance has been negatively stereotyped. These unfavorable perceptions from teachers may increase African American and Latinx students' awareness of negative academic stereotypes towards their racial/ethnic group, which may in turn increase their anxiety towards mathematics and impair their performance. Supporting this hypothesis, research has shown that students from negatively stereotyped racial/ethnic groups are particularly susceptible to negative expectancies from their teachers (McKown & Weinstein, 2002). Future studies should examine whether classroom racial/ethnic demographics and course level relate to teachers' implicit stereotypes about and differential expectations of their students, and whether these factors influence the relationship between students' math anxiety, perceived same-ethnic representation in math class, and math achievement.

4.2 Limitations

The present study has several limitations. The questionnaire used to explore students' attitudes toward mathematics in the current study was developed for the [project name redacted for blind review] and included a relatively small number of items capturing math anxiety, as multiple beliefs about math were measured within the questionnaire. The small number of survey items measuring math anxiety account for the moderately low alpha for this measure. Future studies should consider using established measures of math anxiety that include a greater number of survey items, such as the Mathematics Anxiety Rating Scale (MARS). Another limitation is that math classroom same-racial/ethnic representation was measured using students' perceptions of the proportion of same-ethnic peers,

which may differ from the actual racial/ethnic demographics of the classroom. Future research should consider using school record data to calculate the actual proportion of students from each racial/ethnic group within math classrooms and examine whether this influences students' beliefs about and achievement in mathematics. Future studies may also explore whether there are disparities between students' perceptions of same-ethnic peers in their math class and the actual percentage of same-ethnic peers, to determine whether students' perceptions or the actual composition of classroom same-ethnic representation is more meaningful for math outcomes. Additionally, the present study did not consider the experiences and mathematics outcomes of students from racial/ethnic backgrounds outside of the four major pan-ethnic groups. It is critical for studies to explore whether the findings of this research hold true for students from other racial/ethnic groups that also struggle with representation and performance disparities in mathematics, such as Native Americans (NCES, 2023; NSF, 2022). Finally, the results of this study revealed that students' racial/ethnic identification has a meaningful impact on enrollment across math courses, despite the lack of significant interactions involving this variable. However, the present study explored differences between students enrolled in Algebra 1 and more advanced math courses but did not have a large enough sample to examine students enrolled in remedial math courses. It is critical for future research to probe more deeply into how math anxiety and perceptions of same-ethnic peers in math class relate to the achievement and outcomes of students across all levels of math.

4.3 Conclusion

The present study investigated the interactive effects of math anxiety and perceptions of same-ethnic peers in math class on achievement in mathematics and produced novel findings suggesting that researchers should take a more nuanced approach to examining the impact that high proportions of same-ethnic peers in math classrooms has for students' mathematics outcomes. Considering the large achievement gaps in mathematics between students of different racial/ethnic backgrounds (NCES, 2023; NSF, 2022), it is critical to better understand how factors such as math anxiety and subjective perceptions of classroom racial/ethnic representation contribute to Black and Latinx students' performance in math courses. Understanding how math beliefs and contextual factors influence students' success in math is critical, considering that performance in math is a gateway to high school completion, college admittance, and participation in STEM careers (Long et al., 2012; Neild, 2009).

This research on the role of math class perceived same-ethnic representation in shaping students' beliefs about and performance in mathematics also highlights some of the drawbacks of racialized academic tracking, as it often exists in urban high schools today. Black and Latinx students are often tracked into less rigorous courses and provided with fewer opportunities to enroll in advanced or AP classes (Francis, De Oliveira, & Dimmitt, 2019; Hirschl & Smith, 2023). Access to advanced mathematics courses can improve life outcomes for underrepresented students, such as income, by supporting enrollment in selective colleges (Hirschl & Smith, 2023) and subsequent entry into lucrative STEM careers (Chetty, Friedman, & Rockhoff, 2014). It is imperative for educators and policymakers to address and dismantle academic tracking that disproportionately places Black and Latinx students into lower-level math classes, while also limiting their racial/ethnic representation within more advanced courses (Francis & Darity, 2021). Thus, the present study identifies an area for interventions and policies to target in endeavors to support diverse students' success in mathematics and ensure adequate representation of all racial/ethnic groups within math classrooms. Working towards increasing diversity and representation in mathematics ultimately helps advance social and economic equality for individuals from disadvantaged and marginalized backgrounds.

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Informed Consent

Obtained.

Provenance and Peer Review

Not commissioned; externally double-blind peer reviewed.

Data Availability Statement

The data that support the findings of this study are available on request.

Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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