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RESEARCH ARTICLE

STEM Pipeline: Mathematics Beliefs, Attitudes, and Opportunities of Racial/Ethnic Minority Girls

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Abstract

Racial/ethnic minority girls have a history of being underrepresented in STEM. Yet, there is a dearth of research that identifies the mathematics experiences that predict being on a STEM pipeline. Analyzing data from the Educational Longitudinal Study (ELS: 2002), we examined the relationship between mathematics attitudes, beliefs, and enrichment activities and being on a STEM pipeline among racial/ethnic minority girls. The findings indicated that for Black and Latinx girls, higher levels of mathematics self-efficacy beliefs were associated with being on a STEM pipeline. For American Indian/Alaska Native girls, endorsing a growth mindset was associated with being on a STEM pipeline. For Asian, Hawaii/Pacific Islander girls, mathematics enjoyment was associated with being on a STEM pipeline. Yet, endorsing higher levels of participation in mathematics enrichment activities and mathematics self-efficacy beliefs was associated with lower endorsements of being on a STEM pipeline for Black and American Indian/Alaska Native girls, respectively. Results build on previous work by highlighting important mathematics experiences that impact being on a STEM pipeline for racial/ethnic minority girls.

Keywords Racial/ethnic minority girls · Mathematics · STEM pipeline

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The mathematics success and achievement of US adolescents has been widely studied (e.g., Keys et al., 2012; Mullis et al., 2012; Schenke et al., 2015; Watts et al., 2015). Further, a plethora of research has examined the link between adolescents' beliefs and attitudes about mathematics and STEM outcomes. To date, findings indicate that mathematics beliefs (e.g., self-efficacy) promote STEM interest in high school (Blotnicky et al., 2018; Kwon et al., 2019; Liu & Koirala, 2009). For instance, Blotnicky et al. (2018) found that mathematics self-efficacy beliefs were associated with being more likely to pursue a STEM career. There has also been increased interest in the relationship between endorsing a growth mindset (e.g., *most people can learn to be good at math*) and mathematics achievement. For instance, endorsing a growth orientation towards mathematics is associated with higher levels of student achievement and engagement (Bostwick et al. 2019, 2020). Some scholars have also examined affect towards mathematics finding that enjoyment of mathematics is associated with increases in achievement (Putwain et al., 2018). Despite these findings on the link between adolescents' attitudes and beliefs about mathematics, racial/ethnic minority girls are invisible in this literature. We use the umbrella term *racial/ethnic minority girls* in the present study to describe girls whose racial and ethnic groups are numerical minorities in the USA. This includes Black, Latinx, American Indian/Alaska Native, and Asian, Hawaiian/Pacific Islander girls. More importantly, most of the research on the use of specific mathematics attitudes and beliefs (e.g., self-efficacy, enjoyment, anf growth mindset) do not consider the intersection of race, ethnicity, class, and gender. Thus, this study aims to better understand the unique experiences of specific racial/ethnic subgroups of minoritized adolescent girls and the impact on their math course-taking in high school.

Racial/ethnic minority girls have a history of being discouraged from mathematics-related tasks and careers (Brickhouse & Potter, 2001; Ireland et al., 2018; Johnson, 2011), particularly within the school context. As such, their mathematics beliefs, attitudes, and experiences within the classroom are likely important contributors to their positive performance and persistence (Eccles, 2009; Koch et al., 2019). However, research on the intersectional experiences of youth in K to 12 mathematics classrooms underscores how experiences related to race, ethnicity, and gender creates unique environments for some students (e.g., Gholson & Martin, 2014, 2019; Gholson & Wilkes, 2017; Ireland et al., 2018; Lim, 2008). Furthermore, a key tenet of intersectionality theory indicates that individuals' experiences are shaped as a result of intersectional identities based on existing social hierarchies (Cole, 2009; Crenshaw, 1991). These experiences might also influence whether racial/ethnic minority girls are on a STEM pipeline. Various definitions of STEM pipeline are in the literature. Collectively, STEM pipeline is defined as having an interest in STEM careers throughout high school, participation in STEM programming in high school, and mathematics and science course-taking (Franco & Patel 2017, 2012; Ellis et al., 2016; Subotnik et al. 2009). In our study, we use mathematics course-taking as a proxy for being on a STEM pipeline.

Intersectionality is a useful framework for understanding racial/ethnic minority girls' being on a STEM pipeline because it considers how inequalities stem from systems of oppression (e.g., racism, sexism, classism) and those systems of oppression can create different experiences and subsequent outcomes (Crenshaw et al., 1995). The multiple forms of oppression that racial/ethnic minority girls encounter can inform their social identities and academic belief systems, limit their educational and STEM-specific opportunities, and undermine their being on a STEM pipeline. Within racial/ethnic minority girls, there is diversity in the types of educational opportunities they are likely to encounter based on their racial/ethnic group's histories and socio-cultural contexts. Exploring mathematics attitudes, beliefs, and enrichment experiences through an intersectionality lens allows us to consider how multiple intersecting categorical statuses contribute to differences in being on a STEM pipeline among racial/ethnic minority girls.

Racial and Ethnic Minority Girls and Mathematics Performance

Black Girls To date, the findings suggest that Black girls are one of the lowest performing groups on mathematics standardized tests (National Assessment Education Program, 2019) and are underrepresented in STEM fields (Riegle-Crumb et al., 2010). These patterns of underperformance have expanded over the past two decades (NAEP, 1990–2013), despite subtle increases in mathematics performance over time. Most recently, research has noted the unique racialized and gendered experiences of Black girls in school settings (e.g.,Gholson & Martin, 2014, 2019; Joseph et al., 2018; Neal-Jackson, 2018; Young et al., 2017). The reports *Let Her Learn* and *Unlocking Opportunity for African American Girls* highlights the low academic performance of Black girls (Let Her Learn, 2017; National Women's Law Center, 2014) and the underrepresentation in honor and AP courses, nationally. Additionally, studies that have examined Black girls' mathematics achievement find that they often encounter negative treatment related to their race, gender, and social class that contribute to their academic underperformance (e.g., Gholson & Martin, 2014; Joseph et al., 2018; Neal-Jackson, 2018; Young et al., 2017).

Latinx Girls According to the National Education Assessment Program (NAEP), Latinx girls are underperforming on mathematic standardized tests (NAEP, 2019). Similar to other ethnic and racial minority girls, Latinx girls encounter negative and stereotyped treatment in school contexts, particularly within math and science domains that may negatively impact their attitudes, beliefs, and performance (Alva & De Los Reyes, 1999; Kurtz-Costes et al., 2016; Reyna, 2000). Brown and Leaper (2010) investigated Latinx and White adolescent girls' experiences with academic sexism (i.e., hearing discouraging comments about girls' abilities in math, science, or computers) and their math and science competence and values (liking and importance). They found that perceptions of academic sexism were more strongly linked with lower perceived math and science competence among Latinx girls (existing for Latina girls regardless of age) than White girls (existing only for the oldest girls). It is likely that having multiple identities (gender and ethnicity) that are academically devalued makes Latinx girls more vulnerable or sensitive to negative group-based treatment.

American Indian and Alaska Native Girls In comparison to Black and Latinx girls, the research on the mathematics experiences of American Indian/Alaska Native (AI/AN) girls is sparse. Moreover, the dropout rate among AI/AN students in high schools (by 10th grade) and public universities is the highest compared to any other student group (Patterson-Silver Wolf & Butler-Barnes, 2017; Yamauchi & Tharp, 1995) and AI/AN students make up only 3.3% of earned 4-year degrees in STEM fields (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2010). There has been a long history of mistreatment and colonization within the schooling contexts of Indigenous groups in the USA that has had persistent negative trickle-down effects in AI/AN students' achievement (Faircloth, 2009). For instance, Cheek (1984) highlighted low mathematics expectations as one major concern. This is particularly distressing as AI/AN 12th grade girls are the lowest performing among all racially and ethnically diverse boys and girls (NAEP, 2019).

Asian, Hawaii/Pacific Islander Girls Similar to the dearth of research on American Indian/Alaska Native, there is also a dearth of research examining Asian, Hawaii/Pacific Islanders mathematics attitudes and beliefs. Mau (1990) suggested the important role of disaggregating the data to understand Asian/Pacific Islander female students' race/ethnicity, socioeconomic status, perceived stereotypes, and discriminatory experiences within the classroom as impacting their mathematics learning experiences. For instance, Pang et al. (2011) examined the mathematics achievement scores of Asian Pacific Islanders by disaggregating the data (i.e., Asian Americans). The findings indicated significant achievement gaps in areas of mathematics achievement for Asian Pacific Islanders in comparison to White adolescents — dispelling the model minority myth. This exclusion from statistics because of their representation in the US obscures the rates and patterns of equitable participation in STEM amongst this group (Goel, 2003; Lee, 1997). When data is not disaggregated, this perpetuates this group as an invisible minority — promoting a colorblind ideology and "Whiteness" (Battey, 2013).

Mathematics Attitudes, Beliefs, and Enrichment Activities

Math Self-Efficacy Mathematics beliefs that promote continued or increased motivation to undertake mathematical challenges is associated with positive mathematics achievement outcomes (e.g., Fast et al., 2010; Levpušček et al., 2013). For instance, mathematics self-efficacy beliefs reflect adolescents' confidence in their math pursuits. This confidence in math ability is related to students' mathematics achievement development (e.g., Bong & Skaalvik, 2003) and helps explain the strong relation between childhood and later adolescent mathematics achievement (Watts et al., 2015). In particular, students who perceive themselves as good at mathematics typically perform better on subsequent assessments.

Growth Mindset In addition to adolescents' self-efficacy beliefs, differences in theories of intelligence (growth mindset) also relate to later achievement (Blackwell et al, 2007; Dweck, 1999). Adolescents who endorse incremental theories of intelligence believe that intelligence is malleable, and anyone can gain skills through effort and learning. On the contrary, those endorsing entity theories of intelligence believe that intelligence is fixed and innate and those who perform well in mathematics have a "natural" ability. When faced with difficulties in mathematics, adolescents endorsing entity theories of intelligence are more likely to give up on the task compared to those who believe anyone can have success in math with persistence and effort (Dweck & Leggett, 1988). Research with racial/ethnic minority students show that when incremental theories of intelligence are emphasized, their achievement is increased (Aronson & Steele, 2005).

Math Enjoyment Mathematics self-efficacy and incremental theories of intelligence relating to mathematical ability may inspire adolescents' greater motivation to exercise this ability. Furthermore, positive affective beliefs, such as enjoyment of mathematics and adolescents' behavioral patterns, for example, their level of participation in mathematics courses and tasks (i.e., engagement), also relate to adolescents' later mathematics achievement (e.g., Fredricks et al., 2004). It has been theorized that positive mathematics beliefs about ability promotes subsequent achievement in mathematics by altering student motivation and mathematics-related affect, thereby increasing the likelihood of engaging in mathematics and spending time studying (e.g., Bong & Skaalvik, 2003). Thus, a cyclical relationship may be functioning such that positive self-efficacy and incremental theories reinforce enjoyment of math and engagement in math tasks and similarly, positive affective beliefs and engagement reinforces self-efficacy and incremental theories of mathematics intelligence.

Math Enrichment Math enrichment activities provide in-depth learning experiences for youth. Mathematics enrichment activities can include using computers or doing math on computers, solving math puzzles, conducting experiments with chemistry sets, and going to science museums (Simpkins et al., 2006). The opportunity to engage in specific enrichment activities predict youth's later enrollment in high school and mathematics courses (Kant et al., 2018; Rito & Moller, 1989; Simpkins et al., 2006; Shukla, 2019). In the research literature, enrichment activities encompass various activities that provide an opportunity for youth to build on existing knowledge of mathematics. Enrichment activities also promote higher-order thinking, more interest in computer programming, and enhanced problem-solving strategies (Shukla, 2019). For minority populations, the benefits of enrichment activities are documented. A study conducted by Rito and Moller (1989) found that among Black and Latinx students who participated in a building skills program (e.g., task-oriented problem solving and explaining how one arrives at their answer) had higher post-test gains. Similar findings were found among Indigenous communities who engaged in culturally responsive enrichment activities in mathematics (Kant et al., 2018).

Guiding Theoretical Frameworks

Coll's et al. (1996) Integrative Model for the Study of Developmental Competencies in Minority Children guides our understanding of diverse girls' mathematics experiences. The model highlights how gender, race, and social class create unique ecologies that influence important developmental outcomes, like academic self-concepts and academic success. For instance, the way in which racial/ethnic minority girls think about their math ability might be influenced through exposure to racism or gendered stereotypes around math or a combination of the two (Cogburn et al., 2011; Cole, 2009). Additionally, opportunities provided inside and outside of the classroom might increase the likelihood of being on a STEM pipeline (Cimpian et al., 2020; Maltese & Cooper, 2017; Maltese et al, 2014; Talley & Martinez Ortiz, 2017).

We also use Eccles & Wigfield, (2002) expectancy-value theoretical model to explain the gender gap in mathematics performance and the underrepresentation of women in STEM careers (e.g., Jacobs et al., 2005). According to the model, individuals' expectations for success and the importance or value the individual attributes to available options are primary factors contributing to whether an individual pursues an academic challenge, such as taking an advanced mathematics course in high school (Eccles & Wigfield, 2002). Students' expectations for their success and their value attributed to the domain are largely shaped by their relevant past experiences, socializers' attitudes and expectations, race, ethnicity, gender and cultural stereotypes about the subject matter (e.g., girls are not good in math), and their self-concept of ability. Unfortunately, racial/ethnic minority girls may be more vulnerable than their peers in encountering marginalized treatment relating to their multiple intersecting identities of race, gender, and social class (Cartledge et al., 2001; Meece & Scantlebury, 2006) that can negatively impact their academic beliefs and attitudes and ultimately their performance.

The Current Study

The current study contributes to the dearth of research by examining the mathematics attitudes, beliefs, and enrichment activities and being on a STEM pipeline among a nationally representative sample of racial/ethnic minority girls. Specifically, we examine whether Black, Latinx, American Indian/Alaska Native and Asian, Hawaii/Pacific Islander girls' beliefs and attitudes (e.g., mathematics self-efficacy beliefs & enjoyment of mathematics) and enrichment activities (e.g., participation in science/math fair and in-class opportunities) are associated with being on a STEM pipeline. Previous research has linked more positive beliefs and experiences in mathematics (e.g., Bouchey & Harter, 2005; Valentine et al., 2004) and viewing mathematics ability as malleable (e.g., Dweck, 1999) to higher achievement outcomes; however, racial/ethnic minority girls have been an understudied population on this topic.

Thus, based on previous literatures, we hypothesized that mathematics attitudes, beliefs, and participation in enrichment activities will be associated with racial/ethnic minority girls being on a STEM pipeline. For instance, previous research with adolescents indicates that those who feel efficacious in an academic domain (e.g., Bandura, 1997; Bong & Skaalvik, 2003; Fast et al., 2010; Schunk & Pajares, 2002), students who enjoy and value the subject area (e.g., Eccles & Wigfield, 2002), students who are engaged in classes (e.g., Dotterer & Lowe, 2011), and those who view academic ability as malleable (e.g., Blackwell et al., 2007; Dweck, 1999) have more positive achievement outcomes. Additionally, consistent with this previous work (Maltese et al, 2014; Maltese & Cooper, 2017; Talley and Martinez Ortiz 2017; Weeden et al., 2020), we also hypothesize that enrichment activities would be associated with being on a STEM pipeline.

Method

Participants

The current study used data from the restricted *Educational Longitudinal Study of 2002 (ELS: 2002)*. The ELS: 2002 is a longitudinal study that is designed to assess educational policy and research issues related to academic achievement. The ELS: 2002 data set includes school attributes associated with academic achievement and the transition of different racial/ethnic minority adolescents from high school to post-secondary education. Three rounds of the data are used in this study: the base year survey of 10th graders in 2002, a follow-up of 12th graders in 2004, and another follow-up in 2005 after graduation. The full sample consists of 7,720 female participants, but this analysis divides the sample into four groups of girls— Black, Latinx, American Indian/Alaska Native, and Asian, Hawaii/Pacific Islander, which reduced the sample size to 2,790 participants ($n=970$ Black; $n=1070$ Latinx; $n=60$ American Indian/Alaska Native; and $n=690$ Asian, Hawaii/Pacific Islander) with complete responses for the variables used in this study. The data is weighted using weights developed by the data distributors to compensate for uneven probabilities of being selected for the sample and to adjust for the schools/individuals that did not participate in the survey. Considering the weights, this study's sample of 2,790 participants increased to 572,530 participants ($n=230{,}100$ Black; $n=263{,}780$, Latinx; $n=13{,}490$, American Indian/Alaska Native; and $n=65{,}160$ Asian/Hawaii/Pacific Islander).

Measures

Mathematics Attitudes and Beliefs

Growth Mindset Adolescents' perceptions of the acquisition of mathematics ability were used to measure the mindset of the student. The item "Most people can learn to be good at math" is used as a measure of the growth mindset of the student. After reverse-scoring, the responses ranged from 1, strongly disagree, to 4, strongly agree. Higher scores were indicative of endorsing higher beliefs that most people can learn to be good at math. Previous studies have used this one item in the ELS: 2002 data as an indicator of a growth mindset (Nix et al., 2015; Perez-Felkner et al., 2017).

Mathematics Enjoyment A composite scale developed by the National Center for Education Statistics (NCES) for the ELS: 2002 data set was used to assess mathematics enjoyment to understand students' beliefs and perceptions around mathematics. The scale was comprised of three items ("get totally absorbed in math," "thinks math is fun," and "math is important). The responses, after reverse-scoring, ranged from 1, strongly disagree, to 4, strongly agree. The alphas for Black, Latinx, American Indian/Alaska Native, and Asian/Hawaii/Pacific Islander girls were 0.67, 0.74, 0.70, and 0.76, respectively. Higher scores were indicative of higher mathematics enjoyment beliefs.

Mathematics Self-Efficacy Beliefs Adolescents' mathematics self-efficacy beliefs were assessed to understand students' persistence in the subject area. The scale was comprised of five items (e.g., "can do excellent job on math tests" and "can master math class skills"). The responses ranged from 1, almost never, to 4, almost always. The alphas for Black, Latinx, American Indian/Alaska Native, and Asian/Hawaii/Pacific Islander girls were 0.91, 0.90, 0.91, and 0.92, respectively. Higher scores were indicative of higher mathematics self-efficacy beliefs. This was a composite scale developed by the National Center for Education Statistics (NCES) for the ELS: 2002.

Enrichment Mathematics Activities

Participation in Enrichment Activities To measure in-class and out-of-class learning opportunities, we used four items (i.e., how often do/did you problem-solve in math class?", "how often do/did you explain work to math class orally?", "have you received recognition or participated in a science, math, or technology fair?", and "have you received or participated in a vocational/technical skills competition?"). The final composite scale included these four items and responses were coded as 1, participation in any of the four enrichment activities, and 0, no participation in any of the four enrichment activities. Scores were summed across all four variables, such that higher scores were indicative of more participation in enrichment activities. These items were based on responses from baseline year, in which adolescents were in their 10th grade year. These enrichment activities and being on a STEM pipeline is supported by existing research that suggests students who participate in STEM competitions are more likely to express interest in a STEM-related career at the end of high school than are students who do not participate, even when students' prior career interest in STEM is controlled for (Miller et al., 2017). The amount of time students use during classroom time to apply and communicate are important skills that STEM employers seek out, according to the US Bureau of Labor Statistics' publication *Occupational Outlook Quarterly* (Vilorio, 2014).

Outcome

STEM Pipeline A composite scale by the NCES for the ELS: 2002 data was used to assess the math pipeline. The math pipeline composite variable is comprised of from 1, no math; 2, basic arithmetic; 3, pre-algebra; 4, algebra I/geometry; 5, algebra II/trigonometry; 6, pre-calculus/probability & statistics; 7, calculus; and 8, AP calculus. Higher scores are indicative of higher math-course taking. This information was retrieved from the NCES High School Transcript. This composite scale is created as a proxy for STEM participation and has been used in a previous study in students pursuing a STEM degree (Palardy, 2013).

Demographics

Socioeconomic status (SES) is a composite variable from the NCES created for the ELS: 2002 data that was derived from parent's educational attainment, household income, and parental occupation. Tenth grade mathematics standardized test scores were also used as a covariate.

Results

To examine the association between mathematics attitudes and beliefs (e.g., mathematics self-efficacy and mathematics enjoyment), growth mindset, and enrichment activities and the association with being on STEM pipeline among racial/ethnic minority girls, we conducted four separate ordinary least squares (OLS) regression. The data is analyzed using statistical software R (version 3.4.2, 2017). The dependent variable is based on STEM pipeline (i.e., F1RMAPIP; mathematics pipeline). The independent variables are SES, 10th grade standardized mathematics test score, mathematics self-efficacy, mathematics enjoyment, growth mindset, and enrichment activities. Separate models were conducted for Black, Latinx, American Indian/Alaska Native, and Asian, Hawaii/Pacific Islander.

Means and standard deviations are presented in Table 1. Table 2 provides a breakdown of the total number of racial/ethnic minority girls math course-taking (i.e., STEM pipeline). Correlations for the study variables are in Tables 3 and 4.

Black Girls In Table 5, SES ($b = 0.262$, $p < 0.001$), 10th grade test score ($b = 0.605$, $p < 0.001$), and mathematics self-efficacy ($b = 0.144$, $p < 0.010$) was associated with being on a STEM pipeline. However, being involved in enrichment activities was predictive of lower levels of mathematics course-taking (i.e., STEM pipeline) ($b = -0.121$, $p < 0.05$). This model accounted for 24% of the variance (see Table 5).

Table 1 Descriptive statistics of mathematics attitudes, beliefs, and enrichment activities

			Black		Latinx		American Indian/Alaska Native		Asian, Hawaii/Pacific Islander	
	min	max	n = (unweighted)	weighted	n = (unweighted)	weighted	n = (unweighted)	weighted	n = (unweighted)	weighted
			970	229,270	1060	262,740	60	13,490	690	65,000
Mathematics Self Efficacy (Composite)	1	4	alpha = 0.91		alpha = 0.89		alpha = 0.93		alpha = 0.92	
			2.44 (0.83)	2.42 (0.82)	2.39 (0.78)	2.37 (0.78)	2.43 (0.91)	2.57 (0.99)	2.52 (0.82)	2.54 (0.85)
Mathematics Enjoyment (Composite)	1	4	alpha = 0.65		alpha = 0.74		alpha = 0.54		alpha = 0.75	
			2.48 (0.69)	2.49 (0.70)	2.49 (0.68)	2.48 (0.68)	2.33 (0.61)	2.34 (0.62)	2.58 (0.66)	2.55 (0.68)
Growth Mindset	1	4	3.04 (0.74)	3.05 (0.74)	3.06 (0.73)	3.06 (0.74)	2.98 (0.62)	3.01 (0.63)	3.09 (0.67)	3.04 (0.67)
In/Out School Enrichment	0	4	2.94 (0.84)	2.96 (0.83)	2.93 (0.77)	2.96 (0.77)	2.65 (0.84)	2.65 (0.87)	2.96 (0.81)	2.94 (0.81)
Socioeconomic Status (Standardized)	-2.11	1.8	−0.24 (0.67)	−0.28 (0.64)	−0.40 (0.75)	−0.49 (0.69)	−0.23 (0.75)	−0.14 (0.73)	−0.01 (0.86)	0.03 (0.84)
10th Grade Math Standardized Test Score	20.53	84	43.83 (8.41)	43.31 (8.32)	45.20 (9.40)	44.34 (9.26)	46.47 (7.14)	46.89 (7.35)	53.56 (10.47)	53.94 (10.49)

Variable means with standard deviation in parentheses. Growth mindset = Most people can learn to be good at math

Source: US Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), “Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey.”

Table 2 First follow-up (12th grade) distribution of STEM pipeline

	Black		Latinx		American Indian/ Alaska Native		Asian, Hawaii/ Pacific Islander	
	n	Percent	n	Percent	n	Percent	n	Percent
1. No Math	20	2%	10	1%	0	0%	0	0%
2. Basic Arithmetic	20	2%	20	2%	0	0%	0	0%
3. Pre-Algebra	40	5%	50	5%	0	0%	20	3%
4. Algebra I/Geometry	210	24%	310	32%	20	50%	90	14%
5. Algebra II/Trigonometry	250	29%	270	28%	20	50%	120	18%
6. Pre-Calculus/Probability & Statistics	180	21%	100	10%	0	0%	70	11%
7. Calculus	100	11%	140	14%	0	0%	150	23%
8. AP Calculus	50	6%	70	7%	0	0%	200	31%

Source: US Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), "Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey."

Latinx Girls For Latinx female students, SES ($b=0.173$, $p<0.010$), 10th grade test scores ($b=0.801$, $p<0.001$), and mathematics self-efficacy ($b=0.119$, $p<0.05$) were associated with being on a STEM pipeline. This model accounted for 34% of the variance (see Table 5).

American Indian and Alaska Native Girls For American Indian and Alaska Native girls, 10th grade test scores ($b=1.11$, $p<0.001$) and endorsing a growth mindset ($b=0.428$, $p<0.05$) were associated with being on a STEM pipeline. Additionally, mathematics self-efficacy beliefs ($b=-0.422$, $p<0.05$) was associated with lower levels of being on a STEM pipeline. The model accounted for 41% of the variance (see Table 6).

Asian, Hawaii/Pacific Islander Girls In Table 6, 10th grade test score ($b=1.02$, $p<0.001$) and mathematics enjoyment ($b=0.123$, $p<0.05$) were associated with being on a STEM pipeline. The model accounted for 46% of the variance.

Discussion

Overall, the present study examined the mathematics attitudes, beliefs, and enrichment activities and being on a STEM pipeline among a nationally representative sample of racial/ethnic minority girls. In this study, we lay the groundwork to explore the dimensions that was found in previous literatures that underscore the importance of personal and affective components of mathematics (e.g., mathematics self-efficacy and mathematics enjoyment) and enrichment activities (Schnell & Prediger, 2017). First, we examined mathematics enjoyment beliefs, mathematics self-efficacy beliefs,

Table 3 Pearson correlations between STEM pipeline and predictor variables for Black girls (upper) and Latinx girls (lower)

	1 STEM Pipeline	2 Math Self-Efficacy	3 Math Enjoyment	4 Growth Mindset	5 SES	6 Math Test Score	7 Enrichment Activities
1. STEM Pipeline	——	0.20***	0.11*	0.04	0.24***	0.47***	-0.03***
2. Math Self-Efficacy	0.20***	—-	0.50***	0.33***	0.02	0.20***	0.10***
3. Math Enjoyment	0.08*	0.48***	—-	0.29***	0.00	0.11**	0.09**
4. Growth Mindset	0.00	0.31***	0.40***	——	-0.09***	0.00*	0.12*
5. SES	0.29***	0.08*	-0.02	-0.03	—-	0.29***	0.09***
6. Math Test Score	0.58***	0.22***	0.07*	-0.05	0.38***	—-	0.06
6. Enrichment Activities	0.07*	0.05	0.14***	0.08**	0.09**	0.10**	—-

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), "Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey."

Table 4 Pearson Correlations between STEM pipeline and predictor variables for American Indian/Alaska Native girls (upper) and Asian, Hawaii/Pacific Island girls (lower)

	1	2	3	4	5	6	7
	STEM Pipeline	Math Self-Efficacy	Math Enjoyment	Growth Mindset	SES	Math Test Score	Enrichment Activities
1. STEM Pipeline	—	-0.01	0.18	-0.11	0.21	0.64***	0.06
2. Math Self-Efficacy	0.30***	—	0.28*	0.42**	0.28*	0.21	0.13
3. Math Enjoyment	0.16***	0.49***	—	-0.11	0.20	0.26	0.19
4. Growth Mindset	−0.05	0.23***	0.33***	—	-0.06	-0.35**	-0.12
5. SES	0.28***	0.15***	−0.08**	-0.09*	—	0.33*	0.18
6. Math Test Score	0.68***	0.36***	0.14***	-0.06	0.38***	—	0.18
7. Enrichment	−0.05	0.07	0.02	0.02	0.08*	-0.02	—

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source: US Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), "Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey."

Table 5 Summary of OLS regression for variables predicting STEM pipeline

	Black				Latinx			
			95% CI				95% CI	
Variable	Estimate	SE	LL	UL	Estimate	SE	LL	UL
Intercept	5.541***	0.159	5.230	5.853	5.069***	0.158	4.759	5.379
SES	0.262***	0.067	0.131	0.393	0.173**	0.056	0.063	0.283
10th grade test score	0.605***	0.046	0.515	0.695	0.801***	0.043	0.717	0.885
Self-efficacy	0.144**	0.051	0.044	0.244	0.119*	0.046	0.029	0.209
Enjoyment	0.013	0.050	−0.085	0.111	0.002	0.047	−0.090	0.094
Growth	0.026	0.047	−0.066	0.118	0.011	0.043	−0.073	0.095
Enrichment activities	−0.121*	0.051	−0.221	-0.021	0.017	0.051	−0.083	0.117
Residual standard error (degrees of freedom)	1.253 (860)				1.209 (964)			
F-statistic	48.02 (6,860)***				87.23 on (6,964)***			
R-Squared (adjusted)	0.2457				0.3478			
n	870				970			

*p < 0.05, **p < 0.01, ***p < 0.001

Source: US Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), "Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey."

Table 6 Summary of OLS regression for variables predicting STEM pipeline

	American Indian/Alaska Native				Asian, Hawaii/Pacific Islander			
			95% CI				95% CI	
Variable	Estimate	SE	LL	UL	Estimate	SE	LL	UL
Intercept	4.875***	0.558	3.781	5.969	6.525***	0.180	6.172	6.878
SES	0.06	0.258	−0.446	0.566	0.041	0.061	−0.079	0.161
10th grade test score	1.117***	0.192	0.741	1.493	1.028***	0.054	0.922	1.134
Self-efficacy	−0.422*	0.209	−0.832	-0.012	0.070	0.058	−0.044	0.184
Enjoyment	0.143	0.181	−0.212	0.498	0.123*	0.056	0.013	0.233
Growth	0.428*	0.203	0.030	0.826	-0.081	0.051	−0.181	0.019
Enrichment activities	−0.004	0.197	−0.390	0.382	-0.092	0.059	−0.208	0.024
Residual standard error (degrees of freedom)	1.138 (43)				1.181 (631)			
F-statistic	6.642 on (6,43)***				93.4 on (6,631)***			
R-Squared (adjusted)	0.4086				0.4653			
n	50				640			

*p < 0.05, **p < 0.01, ***p < 0.001

Source: US Department of Education, National Center for Education Statistics, Education Longitudinal Study (ELS:2002), "Baseline year (2002), First Follow-up (2004), High School Transcripts (2005), Student Survey."

enrichment activities, and whether or not having a growth mindset contributed to racial/ethnic minority girls being on a STEM pipeline. Second, we were also interested in whether mathematics enrichment activities were associated with being on STEM pipeline. Our findings revealed unique findings for each racial/ethnic minority group. More specifically, we found that for Black girls, mathematics self-efficacy beliefs were predictive of being on a STEM pipeline. However, contrary to our hypotheses, engagement in mathematics enrichment activities was associated with lower participation on the STEM pipeline for Black girls. Among Latinx girls, mathematics self-efficacy beliefs were associated with being on a STEM pipeline. For American Indian and Alaska Native girls, higher levels of mathematics self-efficacy beliefs were associated with lower endorsements of being on a STEM pipeline. Also, endorsing a growth mindset was associated with being on a STEM pipeline for American Indian and Alaska Native girls. Lastly, Asian, Hawaii/Pacific Islander girls, mathematics enjoyment was associated with being on a STEM pipeline.

The Importance of Mathematics Achievement Attitudes and Beliefs

Math Self-Efficacy In this study, we found that mathematics self-efficacy was important for Black and Latinx female students being on the STEM pipeline. However, mathematics self-efficacy was not a predictor for American Indian and Alaska Native — in fact it was associated with being less likely to be on a STEM pipeline. We speculate that there might be additional underlying processes such as self-concept and self-confidence that might be important for American Indian and Alaska Native female students being on a STEM pipeline. For instance, in a study conducted by Parker et al. (2013), it was found that mathematics self-efficacy was associated with educational aspirations to attend college and not post school studies in STEM. Other studies have examined both the role of GRIT and self-efficacy and found that self-efficacy should be targeted instead of GRIT (Usher et al. 2019). However, Usher and colleagues did not include an American Indian and Alaska Native sample. Future work should continue to examine other personal and affective components of American Indian and Alaska Native girls that might contribute to endorsements of being on a STEM pipeline. Exploring additional outcomes (e.g., achievement motivational tasks and beliefs or STEM interest) should also be considered. For instance, in other studies, mathematics self-efficacy beliefs were associated with a higher-grade point average (GPA) (Bryan, 2004; Downs, 2005) and persistence in post-secondary outcomes for American Indian and Alaska Native (Hill, 2003) children and youth. Furthermore, *interest in pursuing a STEM career* was associated with science-mathematics self-efficacy for Asian adolescents (O'brien et al., 1999). This might explain the non-significant finding of mathematic self-efficacy beliefs for Asian, Hawaii/Pacific Islander girls in the current study. In other words, it might not be that mathematics self-efficacy beliefs are unimportant for Asian, Hawaii/Pacific Islander girls — but additional factor such as interest in pursuing a STEM career is the outcome goal of being on a STEM pipeline. These findings suggest the need for additional research to understand the educational experiences of racial/ethnic minority girls and the role of mathematics self-efficacious beliefs. Thus, we do not suggest that mathematics self-efficacy beliefs are not important, but perhaps additional support systems are relevant within the school and familial setting that predicts being on a STEM pipeline.

Mathematics Enjoyment To our knowledge, very little research has examined the academic emotion of mathematics attitudes and beliefs among a nationally representative sample of racial/ethnic minority girls. Several studies have examined the emotion states of adolescents and the association with mathematics (e.g., Afari et al., 2013; Frenzel et al., 2007; Goetz et al., 2008; Pekrun et al., 2002; Tulis & Ainley, 2011). For instance, Frenzel et al. (2007) examined gender differences towards mathematics and found that girls endorsed less enjoyment of mathematics in comparison to boys. Additionally, Goetz et al. (2008) found that mathematics enjoyment was associated with mathematics achievement. Our study contributes to this work by finding that academic emotion such as mathematics enjoyment was important in predicting the likelihood of racial/ethnic minority girls being on a STEM pipeline. More specifically, in our study, enjoyment of mathematics was a predictor of being on a STEM pipeline for Asian, Hawaii/Pacific Islander girls. Interventions targeted towards academic emotions might be helpful in promoting positive emotions around mathematics in targeting anxiety and lower self-confidence. For instance, Kim and Hodges (2012) developed a mathematics emotion intervention for college students taking an online mathematics course. The findings revealed that students participating in the emotion control treatment group (e.g., promoting positive appraisal, developing student agency in control over negative emotions, and healthy emotional responses) in comparison to control (absence of treatment) were associated with higher performance in the online mathematics course. Overall, our study contributes to the research on the role of positive academic emotions on racial/ethnic minority girls' engagement in the STEM pipeline.

Growth Mindset Despite the literature that underscores the important role of endorsing a growth mindset (Dweck, 2007), this finding was only for American Indian and Alaska Native girls in our sample and was associated with being on a STEM pipeline. For the other groups, growth mindset was not a predictive factor. A growth mindset suggest that intelligence is malleable and can be developed over time. For instance, a growth mindset has been associated with higher academic achievement and mathematics performance (Blackwell et al., 2007; Yeager & Dweck, 2012). With regard to fixed mindsets, Dweck (2007) found girls more susceptible to underperforming when endorsing a fixed mindset. Perhaps examining task and motivational outcomes would provide insight on the role of racial/ethnic minority girls' growth mindset. Other studies have found that growth mindset was associated with female students' achievement motivational outcomes (Degol et al., 2018). Perhaps examining additional outcomes such as academic persistence and academic curiosity would further implicate the role of endorsing a growth mindset for racial/ethnic minority girls. It's also important to note that the significant finding with American Indian and Alaska Native girls underscore the intersectional experiences in endorsing specific types of mathematics attitudes and beliefs. There is an additional need to further examine the role of additional outcomes and the unique experiences of racial/ethnic minority girls endorsing a growth mindset.

Enrichment Activities Based on previous literatures, we were interested in the extent to which engagement opportunities in the classroom (i.e., "how often do/did you problem-solve in math class?", "how often do/did you explain work to math class orally?") and outside the classroom (i.e., participating in science/math fairs and/or vocational/technical skills competition) was associated with being on a STEM pipeline. Contrary to our hypotheses, these activities were only significant for Black girls, but in a negative direction. This finding was unexpected. However, after further exploration of the variable, we speculate that this finding might be due to the fact that for Black girls, participation in these activities might not be culturally responsive. For instance, Ford et al. (2018) suggest that to increase a STEM academic identity for Black girls — in addition to opportunities for problem solving and peer group collaboration — schools should offer a variety of extracurricular activities in addition to in-class enrichment opportunities such as summer STEM programs, mentoring, and culturally responsive pedagogy (Ford et al., 2018).

For the other racial/ethnic minority groups, involvement in enrichment activities was not associated with being on a STEM pipeline. We speculate that these non-significant findings might be due to the fact that there is variation in teaching mathematics in the classroom that is not only limited to the items we used in our study. For instance, Ladson-Billings underscores the important of utilizing culturally responsive pedagogy in classroom instruction (Gutstein & Peterson, 2005; Ladson-Billings, 1995, 2014). Perhaps adolescents' responses to the absence or presence of culturally relevant mathematics instruction would provide additional information on the inclusion of marginalized voices in a field that is rooted in Whiteness (Battey, 2013). Another factor that needs to be considered is the opportunities provided to participate in science/math fairs and/or vocational/technical skills competition. In a more recent study, Steegh et al. (2019) conducted a systematic review on participation in mathematics and science competitions and found that participation in these events favored boys. Because of the unique social positioning of racial/ethnic minority girls, it is important to examine equity in these opportunities.

Limitations

A strength of the study is the focus on a nationally representative sample of racial/ethnic minority girls and how mathematics attitudes, beliefs, and enrichment activities is associated with being on a STEM pipeline. However, a limitation of the study is that we did not examine racial/ethnic minority girls' perceptions of culturally relevant mathematics instruction and opportunities to participate in science and math fair and/or vocational/technical skills competition. Additionally, in this study, we did not examine the role of parental support and encouragement supporting racial/ethnic minority girls being on a STEM pipeline. There is a plethora of studies that document the important role of parental involvement. For instance, Eccles (1993) found that boys received more encouragement in math and science in comparison to girls. Other scholars have noted that for Black parents, in particular, mathematics learning and participation can be conceptualized as racialized experiences (Martin, 2006). More recently, McGee and Spencer (2015) noted the important role of Black parents' awareness of educational inequities in mathematics. Parental involvement also plays a significant role in predicting STEM career aspirations of Latino students and persistence in mathematics (Leslie et al., 1998). Yan and Lin (2005) and Mau (1997) used the National Education Longitudinal Study: 1988 (NELS: 88) and found that high parental expectations were associated with mathematics courses for racial and ethnic minority high school students. Mau (1997) specifically examined the experiences of Asian immigrants and Asian Americans and found that higher parental expectations were reported in comparison to White parents. Another limitation is the lack of measurement invariance with some of the scales used in the study as they might lack evidence of racial/ethnic and gender equivalence for racial/ethnic minority girls. For instance, for American Indian/Alaskan Native girls, we found that in comparison to Black, Latinx, and Asian, Hawaii/Pacific Islander, endorsement of higher self-efficacy beliefs was associated with being less likely to be on a STEM pipeline. Moving forward, it is important to understand if the items are being interpreted the same across samples (Byrne & Watkins, 2003). Thus, future research should continue to examine both the importance of racial/ethnic minority female student perceptions of mathematics instruction in their classroom and the important role of parents in supporting racial/ethnic minority girls.

Another limitation of the study is the small number of American Indian/Alaska Native girls. Additionally, the mathematics attitudes and beliefs and enrichment activities used to measure overall motivation and interest might not be predictors of American Indian/Alaska Native girls being on a STEM pipeline. For instance, Lipka and Adams (2004) found that culturally based mathematics education was associated with higher mathematics performance. House (2001) found that academic self-concept (e.g., self-ratings of academic ability, drive to achieve, mathematical ability, and self-confidence) predicted mathematics achievement. In our study, we examine mathematics self-efficacy beliefs, mathematics enjoyment, growth mindset, and classroom experiences. It might be the case that these variables are not predictors of being on the STEM pipeline for American Indian/Alaska Native girls.

It's also important to disaggregate the category for Asian, Hawaii/Pacific Islanders (e.g., Asian category with the Hawaiian/Pacific Islander population). In one study, Pang et al. (2011) examined the mathematics achievement scores of Asian Pacific Islanders by disaggregating the data (i.e., Asian Americans) and found lower scores for Asian Pacific Islanders. Moving forward, to understand the unique racialized and gendered differences among Asian Pacific Islanders, disaggregation of the data is warranted. Overall, our findings also highlight the important need of mixed methodology in understanding the mathematics experiences of racial/ethnic minority girls. For instance, semi-structured interviews will allow for each group to talk about their unique racialized and gendered experiences within the classroom — centering their experiences as it pertains to gendered racism might explain their participation in their mathematics classroom. This is imperative as some of the scales we used in this study (i.e., mathematics self-efficacy) had a lower alpha for African American girls. The use of mixed methods will provide an opportunity for the researcher to engage in an in-depth analysis to understand how mathematics experiences influence self-processes among racial/ethnic minority girls.

Conclusion

Overall, the study contributes to the dearth of research on examining the mathematics attitudes and beliefs, enrichment activities, of racial/ethnic minority girls and being on the STEM pipeline. According to the National Science Foundation (NSF) (2009), American Indian/Alaska Native, Black, and Latinx women have the lowest participation in STEM fields (i.e., computer sciences, physical sciences, and engineering). Doctoral degrees are also less obtained by Latinx and even smaller for American Indian/Alaska Native and Hawaii/Asian Pacific Islander women (National Science Foundation, 2009). Our research findings build on the previous work by highlighting important factors that are associated with being on a STEM pipeline for racial/ethnic minority girls. It's also important to note that promoting a healthy and equitable environment (Coll et al., 1996; Eccles and Wigfield 2002) and culturally responsive programming (e.g., Gutstein, 2003; Ladson-Billings, 2000) is imperative. For instance, Kitsantas et al. (2011) found that increasing self-efficacy for all students wound shrink the achievement gap, with intentional inclusion of programming targeted to Black, Pan-Asian, American Indian/Alaska Native, and Latinx adolescents. These experiences are paramount for racial/ethnic minority girls STEM career path and also have implications on education. More specifically, because of segregation in the USA and the educational disparities that exist, creating equitable environments and promoting positive attitudes and beliefs about mathematics for racial/ethnic minority girls is imperative. In addition, inequitable access to resources might also explain the types of learning opportunities afforded to racial/ethnic minority girls. To date, Black and Latinx students have limited opportunities to enroll in AP courses (Kolluri, 2018; Patrick et al., 2020). Lack of supportive teachers is also associated with racial/ethnic minority girls being underrepresented in AP courses. For instance, Campbell (2012) found that being more confident in mathematics was associated with teachers being less likely to recommend Black girls for AP courses. In moving this work forward, it is important to consider if racial/ethnic minority girls are less likely to have a variety of math course offerings in high school, what factors contribute to teacher recommendations to enroll in AP courses, and who is more likely to have access to AP calculus in US high schools. Additionally, Black and Latinx youth are concentrated in urban hyper-segregated cities (Orfield & Lee, 2005; Saporita & Sohoni, 2007) and are more likely to attend inequitable schools with less resources (Logan et al., 2012). For instance, Logan and Burdick-Will (2017) found that Black, Latinx, and Native American youth had lower mathematics proficiency scores in comparison to their White peers in urban school settings. To address STEM inequities, scholars suggest that there be STEM focused schools in urban areas to increase ethnic minorities' representation in STEM (see Bullock, 2017; Nasir & Vakil, 2017). Nasir and Vakil, (2017) also suggest that intersectional experiences tied to race and gender in mathematics classrooms further exacerbates the gap in access to equitable learning outcomes in STEM — as racial/ethnic minority girls are less likely to be encouraged to participate in STEM related activities. Using an intersectionality lens (Cole, 2009; Crenshaw, 1991) can allow researchers and educators to better understand the ways youth with diverse social identities are uniquely impacted in mathematics and STEM-related contexts. It is important that actors in youth's lives (educators, parents, and administrators) acknowledge the power and social hierarchies related to race, ethnicity, and gender that explicitly and implicitly undermine youth's positive trajectories in STEM fields. For instance, prevention and intervention efforts focusing only on decreasing the gender gap in mathematics achievement may overlook the unique experiences that racial/ethnic minority girls encounter that may stifle their mathematics achievement. Efforts to engage in dismantling the various systems of oppression (e.g., sexism and racism) that impact individuals with multiple marginalized identities will be necessary to fully support all youth. Our work contributes to this scholarship by highlighting the importance of specific mathematics beliefs and attitudes, and enrichment activities, and being on a STEM pipeline for racial/ethnic minority girls. In moving forward, additional efforts should be geared towards interventions that strengthen academic assets of racial/ethnic minority girls. Attention should also be given to school districts within the USA to ensure an equitable learning environment (e.g., healthy school climate and equitable resources).

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Declarations

Conflict of Interest The authors declare no competing interests.

References

Afari, E., Aldridge, J. M., Fraser, B. J., & Khine, M. S. (2013). Students' perceptions of the learning environment and attitudes in game-based mathematics classrooms. *Learning Environments Research, 16*(1), 131–150. https://doi.org/10.1007/s10984-012-9122-6

Alva, S. A., & De Los Reyes, R. (1999). Psychosocial stress, internalized symptoms, and the academic achievement of Hispanic adolescents. *Journal of Adolescent Research, 14*(3), 343–358. https://doi.org/10.1177/0743558499143004

Aronson, J., & Steele, C. M. (2005). Stereotypes and the fragility of academic competence, motivation, and self-concept. In A. Elliot & C. S. Dweck (Eds.), *The handbook of competence and motivation* (pp. 436–456). Guilford Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Battey, D. (2013). Access to mathematics: "A possessive investment in whiteness." *Curriculum Inquiry, 43*(3), 332–359. https://doi.org/10.1111/curi.12015

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Blotnicky, K. A., Franz-Odendaal, T., French, F., et al. (2018). A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students. *IJ STEM Ed, 5*, 22. https://doi.org/10.1186/s40594-018-0118-3

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review, 15*(1), 1–40. https://doi.org/10.1023/A:1021302408382

Bohrnstedt, G., Kitmitto, S., Ogut, B., Sherman, D., and Chan, D. (2015). *School Composition and the black–white achievement gap* (NCES 2015–018). U.S. Department of Education, Washington, DC: National Center for Education Statistics. Retrieved September 24, 2015 from http://nces.ed.gov/pubsearch.

Bostwick, K. C., Collie, R. J., Martin, A. J., & Durksen, T. L. (2020). Teacher, classroom, and student growth orientation in mathematics: A multilevel examination of growth goals, growth mindset, engagement, and achievement. *Teaching and Teacher Education, 94*, 103100.

Bostwick, K. C., Martin, A. J., Collie, R. J., & Durksen, T. L. (2019). Growth orientation predicts gains in middle and high school students' mathematics outcomes over time. *Contemporary Educational Psychology, 58*, 213–227. https://doi.org/10.1016/j.cedpsych.2019.03.010

Bouchey, H. A., & Harter, S. (2005). Reflected appraisals, academic self-perceptions, and math/science performance during early adolescence. *Journal of Educational Psychology, 97*(4), 673–686. https://doi.org/10.1037/0022-0663.97.4.673

Bradley, C. (1984). Issues in mathematics education for Native Americans and directions for research. *Journal for Research in Mathematics Education*, 96–106.
Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching, 38*(8), 965–980. https://doi.org/10.1002/tea.1041
Brown, C. S., & Leaper, C. (2010). Latina and European American girls' experiences with academic sexism and their self-concepts in mathematics and science during adolescence. *Sex Roles, 63*(11), 860–870. https://doi.org/10.1007/s11199-010-9856-5
Bryan, M. (2004). An examination of Navajo Cultural Identity and its relationship to academic achievement. Unpublished Doctoral dissertation, Brigham Young University, Provo, UT.
Bullock, E. C. (2017). Only STEM can save us? Examining Race, Place, and STEM Education as Property. *, Educational Studies, 53*(6), 628–641. https://doi.org/10.1080/00131946.2017.1369082
Byrne, B. M., & Watkins, D. (2003). The issue of measurement invariance revisited. *Journal of Cross-Cultural Psychology, 34*(2), 155–175. https://doi.org/10.1177/0022022102250225
Campbell, S. L. (2012). For colored girls? Factors that influence teacher recommendations into advanced courses for black girls. *The Review of Black Political Economy, 39*(4), 389–402. https://doi.org/10.1007/s12114-012-9139-1
Carter Andrews, D. J., Brown, T., Castro, E., & Id-Deen, E. (2019). The impossibility of being "perfect and white": Black girls' racialized and gendered schooling experiences. *American Educational Research Journal, 56*(6), 2531–2572. https://doi.org/10.3102/0002831219849392
Cartledge, G., Tillman, L. C., & Johnson, C. T. (2001). Professional ethics within the context of student discipline and diversity. *Teacher Education and Special Education, 24*(1), 25–37.
Cheek, H. N. (1984). Increasing the participation of Native Americans in mathematics. *Journal for Research in Mathematics Education*, 107–113.
Cimpian, J. R., Kim, T. H., & McDermott, Z. T. (2020). Understanding persistent gender gaps in STEM. *Science, 368*(6497), 1317–1319.
Cogburn, C. D., Chavous, T. M., & Griffin, T. M. (2011). School-based racial and gender discrimination among African American adolescents: Exploring gender variation in frequency and implications for adjustment. *Race and Social Problems, 3*(1), 25–37. https://doi.org/10.1007/s12552-011-9040-8
Cole, E. R. (2009). Intersectionality and research in psychology. *American Psychologist, 64*, 170–180.
Coll, C. G., Lamberty, G., Jenkins, R., McAdoo, H. P., Crnic, K., Wasik, B. H., & García, H. V. (1996). An integrative model for the study of developmental competencies in minority children. *Child Development, 67*(5), 1891–1914. https://doi.org/10.1111/j.1467-8624.1996.tb01834.x
Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline (2010). Expanding underrepresented minority participation: America's science and technology talent at the crossroads. Committee on science, engineering, and public policy; Policy and Global Affairs; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine.
Corbett, C., Hill, C., & St Rose, A. (2008). *Where the girls are: The facts about gender equity in education*. American Association of University Women Educational Foundation. 1111 Sixteenth Street NW, Washington, DC 20036.
Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review, 43*, 1241–1299.
Crenshaw, K., Gotanda, N., Peller, G., & Thomas, K. (Eds.). (1995). *Critical race theory: The key writings that formed the movement*. New Press.
Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences, 1*(1), 21–29. https://doi.org/10.1177/2372732214549471
Degol, J. L., Wang, M. T., Zhang, Y., et al. (2018). Do growth mindsets in math benefit females? Identifying pathways between gender, mindset, and motivation. *J Youth Adolescence, 47*, 976–990. https://doi.org/10.1007/s10964-017-0739-8
Dooley, M., Payne, A., Steffler, M., & Wagner, J. (2017). Understanding the STEM path through high school and into university programs. *Canadian Public Policy, 43*(1), 1–16.
Dotterer, A. M., & Lowe, K. (2011). Classroom context, school engagement, and academic achievement in early adolescence. *Journal of Youth and Adolescence, 40*(12), 1649–1660. https://doi.org/10.1007/s10964-011-9647-5

Downs, P. A. (2005). A comparison of student and parent perceptions of academic efficacy, abilities and support: Their impact on Native American high school students' academic achievement. Unpublished doctoral dissertation. Brigham Young University, Provo, UT

Dweck, C. S. (1986). Motivational processes affecting learning Special issue: Psychological science and education. *American Psychologist, 41*(10), 1040–1048.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273. https://doi.org/10.1037/0033-295X.95.2.256

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development*. Psychology Press.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House.

Dweck, C. S. (2007). Is math a gift? Beliefs that put females at risk. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 47–55). American Psychological Association.

Eccles, J. S. (1993). School and family effects on the ontogeny of children's interests, self-perceptions, and activity choice. In J. Jacobs (Ed.), *Nebraska Symposium on Motivation, 1992: Developmental perspectives on motivation* (pp. 145–208). University of Nebraska Press.

Eccles, J. (2009). Who am i and what am i going to do with my life? Personal and Collective Identities as Motivators of Action. *Educational Psychologist, 44*(2), 78–89. https://doi.org/10.1080/00461520902832368

Eccles, J. S., & Wigfield, A. (2002). *Motivational beliefs , values , and goals*.

Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: lack of mathematical confidence a potential culprit. *PLoS ONE, 11*(7), e0157447. https://doi.org/10.1371/journal.pone.0157447

Evans-Winters, V. (2014). Are black girls not gifted? Race, gender, and resilience. *Interdisciplinary Journal of Teaching and Learning, 4*(1), 22–30.

Faircloth, S. C. (2009). Re-visioning the future of education for Native youth in rural schools and communities. *Journal of Research in Rural Education, 24*(9). Retrieved June 1, 2021 from http://jrre.psu.edu/articles/24-9.pdf

Fast, L. A., Lewis, J. L., Bryant, M. J., Bocian, K. A., Cardullo, R. A., Rettig, M., & Hammond, K. A. (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *Journal of Educational Psychology, 102*(3), 729–740. https://doi.org/10.1037/a0018863

Ford, D. Y., Harris, B. N., Byrd, J. A., & Walters, N. M. (2018). Blacked out and whited out: The double bind of gifted black females who are often a footnote in educational discourse. *International Journal of Educational Reform, 27*(3), 253–268. https://doi.org/10.1177/105678791802700302

Franco, M. S., & Patel, N. H. (2017). Exploring student engagement in STEM education: An examination of STEM schools, STEM programs, and traditional schools. *Research in the Schools, 24*(1), 10–30. Retrieved June 1, 2021 from http://libproxy.wustl.edu/login?url=https://www.proquest.com/scholarly-journals/exploring-student-engagement-stem-education/docview/1973741455/se-2?accountid=15159AQ8

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics - A "hopeless" issue? A control-value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education, 22*(4), 497–514. https://doi.org/10.1007/BF03173468

Gholson, M. L. (2016). Clean corners and algebra: A critical examination of the constructed invisibility of black girls and women in mathematics. *The Journal of Negro Education, 85*(3), 290–301.

Gholson, M. L., & Martin, D. B. (2019). Blackgirl face: Racialized and gendered performativity in mathematical contexts. *ZDM - Mathematics Education, 51*(3), 391–404. https://doi.org/10.1007/s11858-019-01051-x

Gholson, M., & Martin, D. B. (2014). Smart girls, black girls, mean girls, and bullies: At the intersection of identities and the mediating role of young girls' social network in mathematical communities of practice. *Journal of Education, 194*(1), 19–33. https://doi.org/10.1177/002205741419400105

Gholson, M. L., & Wilkes, C. E. (2017). (Mis) taken identities: Reclaiming identities of the "collective black" in mathematics education research through an exercise in Black specificity. *Review of Research in Education, 41*(1), 228–252. https://doi.org/10.3102/0091732X16686950

Goel, S. (2003). An invisible minority: Asian Americans in mathematics. *Notices of the AMS*, (March), 878–882.
Goetz, T., Frenzel, A. C., Hall, N. C., & Pekrun, R. (2008). Antecedents of academic emotions: Testing the internal/external frame of reference model for academic enjoyment. *Contemporary Educational Psychology, 33*(1), 9–33. https://doi.org/10.1016/j.cedpsych.2006.12.002
Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education, 34*(1), 37–73. https://doi.org/10.2307/30034699
Gutstein, E., & Peterson, B. (Eds.) (2005). *Rethinking mathematics: Teaching social justice by the numbers*. Milwaukee, WI: Rethinking Schools.
Handwerk, P., Tognatta, N., Coley, R. J., & Gitomer, D. H. (2008). Access to success: Patterns of advanced placement participation in U.S. high schools. Retrieved from: www.ets.org/Media/Research/pdf/PIC-ACCESS.pdf
Heaverlo, C. A., Cooper, R., & Lannan, F. S. (2013). STEM development: Predictors for 6th -12th grade girls' interest and confidence in science and math. *Journal of Women and Minorities in Science and Engineering, 19*(2), 121–142. https://doi.org/10.1615/JWomenMinorScienEng.2013006464
Heilbronner, N. N. (2011). Stepping onto the STEM pathway: Factors affecting talented students' declaration of STEM majors in college. *Journal for the Education of the Gifted, 34*(6), 876–899. https://doi.org/10.1177/0162353211425100
Hemphill, F. C., and Vanneman, A. (2010). *Achievement gaps: How Hispanic and white students in public schools perform in mathematics and reading on the national assessment of educational progress* (NCES 2011–459). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.
Hill, C. L. (2003). Academic achievement and cultural identity in rural Navajo high school students. (Doctoral dissertation, Brigham Young University, 2004). Dissertation Abstracts International, 65-B, 463.
House, J. D. (2001). Predictive relationships between self-beliefs and mathematics achievement of American Indian/Alaska Native students. *International Journal of Instructional Media, 28*(3), 287.
House, J. D. (2009). Mathematics beliefs and achievement of a national sample of Native American students: Results from the trends in international mathematics and science study (TIMSS) 2003 United States assessment. *Psychological Reports, 104*(2), 439–446.
Hwang, N., Reyes, M., & Eccles, J. S. (2016). Who holds a fixed mindset and whom does it harm in mathematics? *Youth & Society, 51*(2), 247–267. https://doi.org/10.1177/0044118X16670058
Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (Un)Hidden figures: A synthesis of research examining the intersectional experiences of black women and girls in STEM education. *Review of Research in Education., 42*(1), 226–254. https://doi.org/10.3102/0091732X18759072
Jacobs, J., Davis-Kean, P., Bleeker, M., Eccles, J., & Malanchuk, O. (2005). "I can, but I don't want to": The impact of parents, interests, and activities on gender differences in math. In A. Gallagher & J. Kaufman (Eds.), *Gender differences in mathematics: An integrative psychological approach* (pp. 73–98). Cambridge University Press.
Johnson, D. R. (2011). Women of color in science, technology, engineering, and mathematics (STEM). *New Directions for Institutional Research, 2011*(152), 75–85.
Joseph, N. M., & Alston, N.V. (2018). We fear no number: Humanizing mathematics teaching and learning for Black girls. In R. Gutierrez & I. Goffney (Eds.), Annual perspectives in mathematics 2018: *Rehumanizing mathematics for Black, Indigenous, and Latinx students* (pp. 51–62). Reston, VA: National Council of Teachers of Mathematics.
Joseph, N. M., Viesca, K. M., & Bianco, M. (2016). Black female adolescents and racism in schools: Experiences in a colorblind society. *The High School Journal, 100*(1), 4–25.
Kaakua, J. K. (2014). *Self-efficacy beliefs and intentions to persist of native Hawaiian and non-Hawaiian science, technology, engineering, and mathematics majors* (Doctoral dissertation, University of Southern California).
Kant, J., Burckhard, S. & Meyers, R. (2018). Engaging high school girls in Native American culturally responsive STEAM activities. *Journal of STEM Education, 18*(5),. Laboratory for innovative technology in engineering education (LITEE). Retrieved April 10, 2021 from https://www.learntechlib.org/p/182466/.
Kao, G. (1995). Asian Americans as model minorities? A look at their academic performance. *American Journal of Education, 103*(2), 121–159. https://doi.org/10.1086/444094

Keys, T. D., Conley, A. M. M., Duncan, G. J., & Domina, T. (2012). The role of goal orientations for adolescent mathematics achievement. *Contemporary Educational Psychology, 37*(1), 47–54. https://doi.org/10.1016/j.cedpsych.2011.09.002

Kim, C. M., & Hodges, C. B. (2012). Effects of an emotion control treatment on academic emotions, motivation and achievement in an online mathematics course. *Instructional Science, 40*(1), 173–192. https://doi.org/10.1007/s11251-011-9165-6

Kitsantas, A., Cheema, J., & Ware, H. W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics, 22*(2), 310–339.

Koch, M., Lundh, P., & Harris, C. J. (2019). Investigating STEM support and persistence among urban teenage African American and Latina girls across settings. *Urban Education, 54*(2), 243–273. https://doi.org/10.1177/0042085915618708

Kolluri, S. (2018). Advanced placement: The dual challenge of equal access and effectiveness. *Review of Educational Research, 88*(5), 671–711. https://doi.org/10.3102/0034654318787268

Kung, H. Y. (2009). Perception or confidence? Self-concept, self-efficacy and achievement in mathematics: A longitudinal study. *Policy Futures in Education, 7*(4), 387–398. https://doi.org/10.2304/pfie.2009.7.4.387

Kurtz-Costes, A. B., Rowley, S. J., Harris-britt, A., Taniesha, A., Kurtz-Costes, B., Carolina, N., & Hill, C. (2016). *Gender stereotypes about mathematics and science and self-perceptions of ability in late childhood and early adolescence published by : Wayne State University Press Stable URL :* http://www.jstor.org/stable/23096251 *Accessed : 13–04–2016 22 : 55 UTC Your u*. *54*(3), 386–409.

Kwon, H., Vela, K., Williams, A., & Barroso, L. (2019). Mathematics and science self-efficacy and STEM careers: A path analysis. *Journal of Mathematics Education*, *12*(1), 66–81. https://doi.org/10.26711/007577152790039

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491. https://doi.org/10.3102/00028312032003465

Ladson-Billings, G. (2000). Culturally relevant pedagogy in African-centered schools: Possibilities for progressive educational reform. *African-centered schooling in theory and practice*, 187–198.

Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: a.k.a. the Remix. *Harvard Educational Review, 84*(1), 74–84. https://doi.org/10.17763/haer.84.1.p2rj131485484751

Lee, O. (1997). Diversity and equity for Asian American students in science education. *Science Education, 81*(1), 107–122. https://doi.org/10.1002/(SICI)1098-237X(199701)81:1%3c107::AID-SCE6%3e3.0.CO;2-M

Leslie, L. L., McClure, G. T., & Oaxaca, R. L. (1998). Women and minorities in science and engineering: A life sequence analysis. *The Journal of Higher Education, 69*(3), 239–276.

Levpušček, M. P., Zupančič, M., & Sočan, G. (2013). Predicting achievement in mathematics in adolescent students: The role of individual and social factors. *Journal of Early Adolescence, 33*(4), 523–551. https://doi.org/10.1177/0272431612450949

Lim, J. H. (2008). The road not taken: Two African-American girls' experiences with school mathematics. *Race Ethnicity and Education, 11*(3), 303–317. https://doi.org/10.1080/13613320802291181

Lipka, J., & Adams, B. (2004). Appalachian collaborative center for learning, assessment and instruction in mathematics culturally based math education as a way to improve Alaska native students ' math performance Jerry Lipka University of Alaska Fairbanks Barbara Adams University of. *Science and Technology, 20*, 1–52.

Liu, X., & Koirala, H. (2009). The effect of mathematics self-efficacy on mathematics achievement of high school students. Retrieved 5/15/2021 from *NERA Conference Proceedings 2009*. 30. https://opencommons.uconn.edu/nera_2009/30

Logan, J. R., Minca, E., & Adar, S. (2012). The geography of inequality: Why separate means unequal in American public schools. *Sociology of Education, 85*(3), 287–301. https://doi.org/10.1177/0038040711431588

Logan, J. R., & Burdick-Will, J. (2017). School segregation and disparities in urban, suburban, and rural areas. *The ANNALS of the American Academy of Political and Social Science, 674*(1), 199–216. https://doi.org/10.1177/0002716217733936

Maltese A. V., & Cooper C. S. (2017). STEM pathways: Do men and women differ in why they enter and exit? *AERA Open*. 3(3), doi:https://doi.org/10.1177/2332858417727276

Maltese, A. V., Melki, C. S., & Wiebke, H. L. (2014). The nature of experiences responsible for the generation and maintenance of interest in STEM. *Science Education, 98*(6), 937–962.

Martin, D. B. (2006). Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning, 8*(3), 197–229.
Mau, R. Y. (1990). Barriers to higher education for Asian/Pacific-American females. *The Urban Review, 22*(3), 183–197. https://doi.org/10.1007/BF01109023
Mau, W. C. (1997). Parental influences on the high school students' academic achievement: A comparison of Asian immigrants, Asian Americans, and White Americans. *Psychology in the Schools, 34*(3), 267–277. https://doi.org/10.1002/(SICI)1520-6807(199707)34:3%3c267::AID-PITS9%3e3.0.CO;2-L
McGee, E., & Spencer, M. B. (2015). Black parents as advocates, motivators, and teachers of mathematics. *The Journal of Negro Education, 84*(3), 473–490.
Meece, J. L., & Scantlebury, K. A. T. H. R. Y. N. (2006). Gender and schooling: Progress and persistent barriers. *Handbook of girls' and women's psychological health*, 283–291.
Miller, K., Sonnert, G., Sadler, P. (2017) The influence of students' participation in STEM competitions on their interest in STEM careers. *International Journal of Science Education, Part B* 1-20 https://doi.org/10.1080/21548455.2017.1397298
Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics* (pp. 139–171). Chestnut Hill, MA: TIMSS & PIRLS International Study Center.
Nasir, N. I. S., & Vakil, S. (2017). STEM-focused academies in urban schools: Tensions and possibilities. *Journal of the Learning Sciences, 26*(3), 376–406. https://doi.org/10.1080/10508406.2017.1314215
National Science Foundation, Division of Science Resources Statistics, 2009, Women, minorities, and persons with disabilities in science and engineering: 2009 (NSF 09–305) (Arlington, VA), Table C-14.
National Women's Law Center. (2014). *Unlocking opportunity for African American Girls: A call to action for educational equity*. Retrieved January, 15, 2020 at https://nwlc.org/resources/unlocking-opportunity-african-american-girls-%20call%20action-educational-equity/.
Neal-Jackson, A. (2018). A meta-ethnographic review of the experiences of African American girls and young women in K–12 education. *Review of Educational Research, 88*(4), 508–546. https://doi.org/10.3102/0034654318760785
Nix, S., Perez-Felkner, L., & Thomas, K. (2015). Perceived mathematical ability under challenge: A longitudinal perspective on sex segregation among STEM degree fields. *Front. Psychol., 6*, 530. https://doi.org/10.3389/fpsyg.2015.00530
O'brien, V., Kopala, M., & Martinez-Pons, M. (1999). Mathematics self-efficacy, ethnic identity, gender, and career interests related to mathematics and science. *Journal of Educational Research, 92*(4), 231–235. https://doi.org/10.1080/00220679909597600
Onyeka-Crawford, A., Patrick, K., & Chaudhry, N. (2017). Let her learn: Stopping school pushout for racial/ethnic minority girls. National Women's Law Center. Retrieved April 1, 2020 from online: https://nwlc.org/wp-content/uploads/2017/04/final_nwlc_Gates_GirlsofColor.pdf
Orfield, G., & Lee, C. (2005). *Why segregation matters: Poverty and educational inequality*. Civil Rights Project., Harvard University.
Palardy, G. J. (2013). High school socioeconomic segregation and student attainment. *American Educational Research Journal, 50*(4), 714–754. https://doi.org/10.3102/0002831213481240
Pang, V. O., Han, P. P., & Pang, J. M. (2011). Asian American and pacific islander students: Equity and the achievement gap. *Educational Researcher, 40*(8), 378–389. https://doi.org/10.3102/0013189X11424222
Parker, P. D., Marsh, H. W., Ciarrochi, J., Marshall, S., & Abduljabbar, S. A. (2014). Juxtaposing math self-efficacy and self-concept as predictors of long-term achievement outcomes. *Educational Psychology, 34*(1), 29–48. https://doi.org/10.1080/01443410.2013.797339
Patrick, K., Rose Socol, A., & Morgan, I. (2020). Inequities in advanced coursework.
Patterson-Silver Wolf, D. A., & Butler-Barnes, S. T. (2017). Impact of the academic-social context on American Indian/Alaska Native students' academic performance. *Journal on Race, Inequality, and Social Mobility in America*: 1: Iss. 1 , Article 3. DOI: https://doi.org/10.7936/K7XW4H60
Putwain, D. W., Becker, S., Symes, W., & Pekrun, R. (2018). Reciprocal relations between students' academic enjoyment, boredom, and achievement over time. *Learning and Instruction, 54*, 73–81. https://doi.org/10.1016/j.learninstruc.2017.08.004
Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Positive emotions in education. In E. Frydenberg (Ed.), *Beyond coping: Meeting goals, visions, and challenges* (pp. 149–174). Elsevier.

Perez-Felkner, L., Nix, S., & Thomas, K. (2017). Gendered pathways: How mathematics ability beliefs shape secondary and postsecondary course and degree field choices. *Front. Psychol., 8*, 386. https://doi.org/10.3389/fpsyg.2017.00386

Riegle-Crumb, C., & King, B. (2010). Questioning a white male advantage in STEM: Examining disparities in college major by gender and race/ethnicity. *Educational Researcher, 39*(9), 656–664. https://doi.org/10.3102/0013189X10391657

Reyna, C. (2000). Lazy, dumb, or industrious: When stereotypes convey attribution information in the classroom. *Educational Psychology Review, 12*(1), 85–110. https://doi.org/10.1023/A:1009037101170

Riconscente, M. M. (2014). Effects of perceived teacher practices on Latino high school students' interest, self-efficacy, and achievement in mathematics. *The Journal of Experimental Education, 82*(1), 51–73. https://doi.org/10.1080/00220973.2013.813358

Rito, G. R., & Moller, B. W. (1989). Teaching enrichment activities for minorities: TEAM for success. *The Journal of Negro Education*, *58*(2), 212–219. https://www.jstor.org/stable/2295594

Schenke, K., Lam, A. C., Conley, A. M. M., & Karabenick, S. A. (2015). Adolescents' help seeking in mathematics classrooms: Relations between achievement and perceived classroom environmental influences over one school year. *Contemporary Educational Psychology, 41*, 133–146. https://doi.org/10.1016/j.cedpsych.2015.01.003

Schnell, S., & Prediger, S. (2017). mathematics enrichment for all – noticing and enhancing mathematical potentials of underprivileged students as an issue of equity. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(1), 143–165. https://doi.org/10.12973/eurasia.2017.00609a

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 16–32). Academic Press.

Shukla, A. (2019). On teaching mathematics to gifted students: Some enrichment ideas and educational activities. arXiv preprint arXiv:1911.1072.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*(1), 70–83. https://doi.org/10.1037/0012-1649.42.1.70

Smith-Evans, L., George, J., Graves, F. G., Kaufmann, L. S., & Frohlich, L. (2014). Unlocking opportunity for African American girls: A call to action for educational equity. *Washington, DC: National Women's Law Center. Retrieved March*, *10*, 2015.

Steegh, A. M., Höffler, T. N., Keller, M. M., & Parchmann, I. (2019). Gender differences in mathematics and science competitions: A systematic review. *Journal of Research in Science Teaching, 56*(10), 1431–1460. https://doi.org/10.1002/tea.21580

Subotnik, R. F., Tai, R. H., Rickoff, R., & Almarode, J. (2009). Specialized Public High Schools of science, mathematics, and technology and the STEM pipeline: What do we know now and what will we know in 5 years? *Roeper Review, 32*(1), 7–16. https://doi.org/10.1080/02783190903386553

Talley, K. G., & Martinez Ortiz, A. (2017). Women's interest development and motivations to persist as college students in STEM: A mixed methods analysis of views and voices from a Hispanic-Serving Institution. *IJ STEM Ed, 4*, 5. https://doi.org/10.1186/s40594-017-0059-2

Tulis, M., & Ainley, M. (2011). Interest, enjoyment and pride after failure experiences? Predictors of students' state-emotions after success and failure during learning in mathematics. *Educational Psychology, 31*(7), 779–807. https://doi.org/10.1080/01443410.2011.608524

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990–2013 Mathematics and Reading Assessments.

U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09), First follow-up and high school transcript study public-use file. See *HSLS:09 2013 update and high school transcript study: A first look at fall 2009 ninth-graders in 2013*.

U.S. Department of Education, National Center for Education Statistics. (2014). *The condition of education 2014* (NCES 2014–083), International Assessments.

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1990, 1992, 1994, 1996, 1999, 2004, 2008, and 2012 Long-Term Trend Mathematics Assessments.

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2019 Mathematics Assessment.

Usher, E. L., Li, C. R., Butz, A. R., & Rojas, J. P. (2019). Perseverant grit and self-efficacy: Are both essential for children's academic success? *Journal of Educational Psychology, 111*(5), 877–902. https://doi.org/10.1037/edu0000324

Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist, 39*(2), 111–133.

Vilorio, D. (2014). STEM 101: Intro to Tomorrow's Jobs. *Bureau of Labor Statistics - U.S. Department of Labor*. Retrieved June 1, 2020 from www.bls.org/ooq

Watts, T.W., Duncan, G.J., Chen, M., Claessens, A., Davis-Kean, P.E., Duckworth, K. … Susperreguy, M.I. (2015) The role of mediators in the development of longitudinal mathematics achievement associations. *Child Development* 86 (6) 1892-1907. https://doi.org/10.1111/cdev.12416

Weeden, K. A., Gelbgiser, D., & Morgan, S. L. (2020). Pipeline dreams: Occupational plans and gender differences in STEM major persistence and completion. *Sociology of Education, 93*(4), 297–314. https://doi.org/10.1177/0038040720928484

Yan, W., & Lin, Q. (2005). Parent involvement and mathematics achievement: Contrast across racial and ethnic groups. *Journal of Educational Research, 99*(2), 116–127. https://doi.org/10.3200/JOER.99.2.116

Yamauchi, L. A., & Greene, W. L. (1997). Culture, gender, and the development of perceived academic self-efficacy among Hawaiian adolescents.

Yamauchi, L. A., & Tharp, R. G. (1995). Culturally compatible conversations in Native American classrooms. *Linguistics and Education, 7*(4), 349–367. https://doi.org/10.1016/0898-5898(95)90009-8

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist, 47*(4), 302–314. https://doi.org/10.1080/00461520.2012.722805

Young, J. L., Young, J. R., & Capraro, M. M. (2017). Black Girls' achievement in middle grades mathematics: How can socializing agents help? *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 90*(3), 70–76. https://doi.org/10.1080/00098655.2016.1270657

Zaragoza-Petty, A. L., & Zarate, M. E. (2014). College access factors of urban Latina girls: The role of math ability perceptions. *Journal of Urban Learning, Teaching, and Research, 10*, 64–72.