Examining Factors That Influence BIPOC Students' Enrollment in STEM Postsecondary Majors

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Abstract

Existing research has studied the underrepresentation of Black, Indigenous and People of Color (BIPOC) students enrolling in and graduating from science, technology, engineering, and mathematics (STEM) fields in college (e.g., Okahana et al., 2018; Rincón & Lane, 2017). However, there is a dearth of research that examines the precollegiate factors that impact whether a student majors in a STEM field (Moakler & Kim, 2014). This study uses binary logistic regression and moderated binary logistic regression to examine the influences that gender, mathematics (math) identity, science identity, career expectations at age 30, and high school STEM credit completion have on BIPOC students' postsecondary major (STEM or non-STEM). Based on the logistic regression results, our study indicates that gender, science identity, career expectations at age 30, and high school STEM credit completion significantly predict the odds of postsecondary enrollment in a STEM

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major. In addition, our ad hoc analysis confirms that gender moderates the relationship between science identity and the likelihood of a STEM collegiate major. These results can aid researchers and practitioners in investigating opportunities to improve STEM participation for BIPOC students.

Keywords: STEM identity; STEM career expectation; math and science credit completion; STEM enrollment

INTRODUCTION

A robust body of research emphasizes how science, technology, engineering, and mathematics (STEM) education settings are often unwelcoming to minoritized students (Bang & Medin, 2010; Martin, 2013; McGee, 2021), including female students and Black, Indigenous, and People of Color (BIPOC) students. Research illuminates how STEM opportunities are uneven across different identity groups (National Center for Science and Engineering Statistics [NCSES], 2019). While BIPOC students are equally likely to show interest in and to choose STEM majors when they enter college compared to their White peers (Beasley & Fischer, 2012; Ma & Xiao, 2021), there remains the concern for underrepresentation during their persistence along the STEM pathways, including whether they will choose a STEM major (Chang et al., 2014; Foltz, et al., 2014; Moakler & Kim, 2014), complete a STEM degree (Foltz et al., 2014; Rincón & Lane, 2017), and participate in the STEM workforce (NCSES, 2019). Various studies document BIPOC students' experiences of feeling invisible and excluded, unevaluated, underrecognized, and marginalized in STEM (Malone & Barrabino, 2009; Morton & Parsons, 2018; Nasir & Vakil, 2017). Using the High School Longitudinal Study of 2009 (HSLS:09) (National Center for Education Statistics [NCES], 2009) data set, the current study examines the influences that gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion have on BIPOC students' postsecondary major (STEM or non-STEM). Our study contributes to emerging quantitative research that centers on the experiences of underrepresented students in STEM disciplines.

LITERATURE REVIEW

In this section we analyze the literature that discusses BIPOC students' persistence in STEM majors, STEM identity, sense of belonging, high school math and science credit completion, and STEM career expectation to articulate the potential influences of these components. We elaborate each of these components.

BIPOC Students' Persistence in STEM Majors

BIPOC students' persistence in STEM majors is portrayed in the literature through discussions on the structural inequities that constrict those students' access to STEM (Hubbard & Stage, 2009; National Science Foundation [NSF], 2017), participation (Boucher et al., 2017; Foltz et al., 2014), completion (Okahana et al., 2018), and thus representation (NCSES, 2019) in both STEM college majors and in the STEM workforce. Wang (2013) presented an interconnected web of variables that provide the context for when a high school student persists through and majors in a postsecondary STEM program. Wang's study highlighted strong impacts of 12th-grade math achievement, exposure to math and science resources, as well as the impact that math self-efficacy beliefs have on students' intent to major in STEM. When examining the precollegiate variables, the author observed how these interrelated factors occur differently by race and indicated a stronger presence of desirable academic outcomes related to majoring in STEM for White students than for BIPOC students.

The literature focusing on BIPOC students' persistence in STEM highlights efforts and characteristics of those who are retained in STEM and who are experiencing success (Chang et al., 2014; Covington et al., 2017; Foltz et al., 2014). This research highlights a range of supportive factors, including (1) familial expectations and supports (Ceglie & Settlage, 2016; Dotterer, 2022; Foltz et al., 2014); (2) high school academic preparation (Griffith, 2010; Palmer et al., 2011); (3) out-of-school STEM-related activities (Taylor, 2019); (4) participation in undergraduate research and presence of collegiate faculty support (Chang et al., 2014; Estrada et al., 2018; Foltz et al., 2014); (5) STEM involvement with peer groups, academic clubs, or organizations (Chang et al., 2014); (6) financial aid (Foltz et al., 2014); and (7) self-efficacy and self-beliefs about the STEM discipline (Carpi et al., 2017; McClure et al., 2007).

STEM Identity

Research from the field of psychology has situated understandings of how an individual develops identities as an internal, cognitive process (Cote & Levine, 2002; Erikson, 1968). Meanwhile, sociological perspectives focus on social interactions—encompassing roles, structures, and practices—leading to the formation of one's identity (Weigert, 1986). The notion of STEM identity connects closely to these theoretical viewpoints, and explores self-concept as suitable for a STEM discipline and/or career. It is, however, important to note that there has been a shift from research that views STEM identity as an assumed, stable characteristic to one that examines the different trajectories of identification (Nasir & Cooks, 2009; Nasir & Hand, 2008; Polman, 2012) in which students relate with STEM both academically (Nasir, 2011) and professionally (Ong et al., 2018) across time and space. This literature depicts numerous self-concepts and values (Avraamidou, 2020; Hazari et al., 2010;) and carefully examines the embedded sociocultural contexts to better understand various ways that learners negotiate and transform their STEM learning (Morton & Parsons, 2018; Nasir et al., 2020; Tran et al., 2023; Wortham, 2004).

Sense of Belonging

Malone and Barrabino (2008) articulated a prominent issue in STEM education settings, in which BIPOC students experience being the only minority student in their classes. The authors emphasized the racialization of identity in which BIPOC students are not recognized as possessing relevant traits, rights, and obligations as scientists. Racialization of identity is associated with (1) students' experiences of isolation, (2) interactions that emphasize the salience and disapproval of their racial identities, (3) and struggles for recognition of their knowledge and disposition in the fields. Being *the only one* is among numerous equity issues (see Carlone et al., 2011; Miller et al., 2006; Strayhorn et al., 2013) repeatedly experienced by minority students, despite their desire and agency to explore and transform STEM education (Miller et al., 2018). This relates to students' sense of belonging—in other words, to their connection with the discipline, which is integral to their decision to either stay in or leave STEM majors (Chen et al., 2020; Rainey et al., 2018). An ample body of research documents the lack of sense of belonging among BIPOC students in their STEM majors as compared to White and Asian counterparts (Rainey et al., 2018), noting this pattern exacerbates even more among BIPOC women in STEM (see Dortch & Patel, 2017; Jong et al., 2020; Morton & Parsons, 2018).

The development of STEM identity has been largely supported in the literature by its relations to sense of validation; knowledgeability (Carlone & Johnson, 2007; McDonald et al., 2019; Seyranian et al., 2018); and engagement, persistence, and matriculation (Aschbacher et al., 2010; Estrada et al., 2018). There is profound research that details factors that challenge and/or support BIPOC students in particular and underrepresented students in general throughout their STEM identity development (Carlone & Johnson, 2007; A. Johnson et al., 2011; Jong et al., 2020). In particular, this literature connects STEM identification processes with support and recognition by family, peers, and educators (Collins & Roberson, 2020; Russell & Atwater, 2005), together with meaningful, validating experiences in different STEM learning environments and communities (Carpi et al., 2017; Lane, 2016; Morton & Parsons, 2018; Rodriguez et al., 2019; Tran et al., 2023).

High School Math and Science Credit Completion

The literature repeats racial disparities in math and science preparation (Strayhorn et al., 2013; Tyson et al., 2007); studies describing the trajectories of BIPOC students in STEM fields find that math and science courses they take before starting college are relative to discipline disposition and future advanced performance (Young et al., 2017), test scores achievement (Anderson, 2016), career interests (Sadler et al., 2014), and college persistence (Foltz et al., 2014). Fouad and Santana (2017) conducted a meta-analysis of factors influencing choices, decision, and barriers experienced by female and BIPOC students in STEM disciplines, calling attention to their math and science preparation and success in middle and early high school levels. With strong evidence connecting STEM preparation, identity, engagement, and career pathway (Anderson, 2016; Palmer et al., 2011; Sadler et al., 2014; Wang, 2013; Young et al., 2017), engagement in high school math and science courses could provide key opportunities for BIPOC students to explore STEM interests and to strengthen a sense of efficacy from an early age.

STEM Career Expectation

STEM career expectation and aspiration are associated with positive learning attitude and interest (Nugent et al., 2012); identification (Hazari et al., 2010); as well as decidedness, goal clarity, and productive engagement in the career process (Goff et al., 2020). At the K–12 level, Mau and Li (2018) drew data from the HSLS:09 (NCES, 2009) sample to examine characteristics influencing whether a high school student aspires to pursue STEM careers by the time they are 30 years old. This study determined that race, gender, socioeconomic status, math interest, and science self-efficacy are the most important factors for determining a student's aspiration for a career in STEM. At the college level, Mau et al. (2016) maintained that there were significant gender and racial differences in how students make the decision whether to pursue STEM careers. Interestingly, Carpi et al. (2017) described the design of an undergraduate research program in a minority-serving institution, one that encouraged students to explore and reflect on their potential to persist as a STEM professional. The authors reported that students' participation in the program yielded increased experience, skills, and career ambition in STEM.

Our literature review repeats the existing discussion concerning racial disparities and inequities in STEM disciplines. This review allows us to further our critical, quantitative, and large-scaled investigation on the multileveled factors and mechanisms influencing the enrollment and persistence of BIPOC students in postsecondary STEM majors.

METHODS

Researcher Positionality

All authors of the current study enrolled in the Spring 2021 National Center for Education Statistics (NCES) Data Institute to gain knowledge of NCES databases and to learn how federal data are archived and used from K–12 through postsecondary education settings. Out of 34 attendees, the five authors of this study were grouped based on our shared interest in STEM education. In our first group meeting, all team members made clear a shared orientation with critical theories, a shared positionality for social justice, and a shared interest in engaging in research that centers the competence and agency of historically minoritized students. During our weekly meetings, we engaged in conversations that recognized structural racism and sexism in the United States' educational system in general and in STEM disciplines in particular, and identified how such systemwide marginalization in many ways results in the underrepresentation and othering of historically minoritized students. Benefiting from the interdisciplinary characteristic of our team (whose interests and expertise include Learning Sciences and Human Development, Mental Health and Well-Being in Higher Education, Educational Measurement and Statistics, Equity, and Inclusion in Higher Education), we unpacked various examples relating to how data and methods are not neutral, and how quantitative data and methods are often used to reinforce deficit worldviews on students who are not identified as heterosexual White men. While acknowledging limitations and constraints that bar us from fully recognizing and honoring the identity, diversity, and agency of BIPOC students in STEM disciplines, we are committed to providing a timely example for how large-scale quantitative analysis can be conducted in the way that distinguishes sociohistorical contexts embedded in the learning and dispositions of students throughout their STEM learning efforts.

We acknowledge that our study and its findings are not neutral. On the contrary, our decision making—which involved (1) brainstorming and crafting the research question; (2) reviewing the literature; (3) selecting the data set, sample of interest, and model for analysis; and (4) cleaning and manipulating data—was profoundly influenced by the named theoretical orientation and positionality, as well as by researchers' personal and professional factors. For example, to decenter whiteness and to avoid an improper methodological approach that compares White and non-White students without considering and adjusting for broader social historical context (Rios-Aguilar, 2014), we limited our sample to only BIPOC students.

Data Set, Sample, and Coding

We examined nationally representative longitudinal data from the HSLS:09 (NCES, 2009). The HSLS:09 originally surveyed more than 24,000 students who were selected from a nationally representative sample of 944 U.S. high schools. Also invited to complete surveys were those students' parents, math and science teachers, and counselors. The surveyed schools were public (including charter), private, and Catholic. The first survey was done in 2009, with two follow-up surveys in 2012 and 2016. Our sample specifically consists of all BIPOC students in the HSLS:09 data set, which included 5,702 participants in the final analysis across the three years: 2009, 2012, and 2016. BIPOC students included those identified as Hispanic; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; and Other Race or Multiracial. Oversampling the subgroups was used to allow for adequate reporting by race or ethnicity (Ingels et al., 2013). The percentages of the population, while oversampled, were still consistent with the distribution of the U.S. population of students in 2009 based on data from the National Center for Education Statistics (NCES, 2022), which indicate that 1% of the school-age population were American Indian or Alaska Native, 5% were Asian, 17% were Black or African American, and 22% were Hispanic. Native Hawaiian or Other Pacific Islander and individuals from two or more races were not reported by all states and were thus excluded from the 2009 report. As shown in Table 1, 51.8% of students in our sample identified as female and 48.2% identified as male. For the breakdown of race or ethnicity, the majority of our sample identified as Hispanic (45.5%), followed by Black or African American (28.3%). See Table 1 for details.

All students included in the study were enrolled in the 9th grade during the fall term of 2009. We used variables for this study from the baseline year (2009), the first follow-up year (2012), and the second follow-up year (2016); students were thus in Grade 9, in their first year of college, and in their fourth year of college, respectively, during the period of data collection. HSLS's variables included in this investigation are as follows:

1| Gender[1] (X2SEX)

2| Race or ethnicity (X2RACE)

3| Expected STEM occupation at age 30 (X4OCC30STEM1)

4| STEM first major (X4RFDGMJSTEM)

5| STEM credits taken in high school (X3TCREDSTEM)

6| Math identity (X2MTHID)

7| Science identity (X2SCIID)

Table 1. Distribution of Sample by Gender and by Race or Ethnicity

Variable	**Category**	***N***	**Percent**
Gender			
	Female	2,954	51.8
	Male	2,748	48.2
Race or Ethnicity			
	American Indian or Alaska Native	83	1.5
	Asian	418	7.3
	Black or African American	1,611	28.3
	Hispanic	2,596	45.5
	More than one race	937	16.4
	Native Hawaiian or Other Pacific Islander	57	1.0

1. The HSLS:09 survey structured gender identity questions into a two-staged process. In the baseline and first follow-up surveys, students were asked to report their sex at birth. Current gender identity (with more than two options) was asked in the second follow-up survey.

Prior to conducting the statistical analysis, the career expectations variable was recoded into STEM[2] and non-STEM options, and the remaining data were considered missing. Hispanic ethnicity was recoded by combining “Hispanic,” “no race specified and Hispanic,” and “race specified and Hispanic.” We used categories as they were originally classified in the HSLS:09 (NCES, 2009) survey for gender (i.e., male and female) and race or ethnicity. For the STEM first major variable (X4RFDGMJSTEM), we excluded the college students who indicated “Don’t know” for their major. Those who included their first major (some students indicated more than one major) as STEM and non-STEM were already coded in the HSLS:09 data set so they were analyzed as-is. For the expected variable of STEM occupation at age 30 (X4OCC30STEM1), the original data were divided into a non-STEM category and several different major STEM categories and then combined by the researchers to create one STEM variable. The STEM credits taken in high school variable (X3TCREDSTEM) was numeric and ranged from 0 to 16 credits as was left as it was originally coded in the HSLS:09 data set. Math identity (X2MTHID) and science identity (X2SCIID) were preserved as they were in the original HSLS:09 data set where they were presented by z score values. Specifically, students reported a math identity and a science identity measure, where the converted z score of 0 was indicative of moderate math identity and science identity, respectively. Scores above and below $z = 0$ were indicative of higher-than-average math identity or science identity and lower-than-average math identity or science identity, respectively.

Descriptive Results

Our descriptive analysis provides insights into students represented in our sample and their perceptions on STEM involvement throughout high school and college (see Tables 1, 2, and 3). Descriptive information regarding STEM identity perceptions, career expectations, completed STEM credits in high school, and postsecondary major

Table 2. Math Identity, Science Identity, and STEM Credits Earned for BIPOC Students

Variable	Mean	SD	Minimum	Maximum	*N*
Math Identity	.01	.99	−1.54	1.82	5,702
Science Identity	−.05	.97	−1.74	1.86	5,702
STEM Credits Earned	7.0	3.0	0.00	16.00	5,702

Table 3. Expected STEM Occupation at Age 30 and STEM First Major for BIPOC Students

Variables	Category	*N*	Percent
Expected STEM Occupation at Age 30			
	Non-STEM	2,133	62.1
	STEM	1,301	37.9
STEM First Major			
	Non-STEM	3,106	79.9
	STEM	781	20.1

2. The six STEM categories, including (1) Life and Physical Science, Engineering, Mathematics, Information Technology; (2) Social Science; (3) Architecture; (4) Health, (5) expected occupation split across two STEM-related occupations (not specified); as well as (6) STEM occupation with no specificity, were combined into the one STEM category.

(STEM or non-STEM) were also examined (see Tables 2 and 3). BIPOC students reported approximately an average identification with math (*M* = .01, *SD* = .99).[3]

BIPOC students reported a little less than average identification with science (*M* = –.05, *SD* = .97). For high school completion of STEM credits, BIPOC students on average completed approximately seven STEM credits (*M* = 7.02, *SD* = 2.99). At 30 years old, 37.9% of BIPOC students expected to be in a STEM occupation. Finally, once BIPOC students entered postsecondary education, 20.1% reported majoring in STEM.

Correlation Analysis

A correlational analysis was conducted to assess the association between demographic data, the independent variables, and the dependent variable of the study (see Table 4). The majority of the correlations were positive associations and statistically significant. Given the large sample size, the statistical significance was not surprising, but since *r* is already a measure of effect size, we focused on the *r* values to determine practical significance in addition to statistical significance. Our correlation analysis showed that strong associations did not exist between any of the variables. According to Cohen (1992), *r* values that are less than .30 indicate small effect sizes. As shown in Table 4, the positive and statistically significant correlations were relatively weak, with r values ranging from .01 to .28. Similarly, the negative and statistically significant correlations ranged from –0.01 to –0.19. This suggested that multicollinearity was not an issue in our sample, meaning predictor variables were not necessarily related in explaining the dependent variable—students' postsecondary enrollment in a STEM major. It is worth noting that, while all variables were statistically significantly associated with postsecondary enrollment in STEM majors, the weak association suggests that there may be confounding factors that were not measured in this study, factors that have more influence on students' choices to enroll in a STEM major.

Data Analysis

Our research question is, "Does gender, science and math identity, career explorations, and high school STEM credit completion influence BIPOC students' postsecondary enrollment in a STEM major?" For

Table 4. Correlations between Study Variables

	1.	**2.**	**3.**	**4.**	**5.**	**6.**
Gender	—					
Math Identity	–0.06	—				
Science Identity	0.01	0.20	—			
Career Expectations at Age 30	0.20	0.13	0.22	0.13	—	
High School STEM Credit Completion	–0.01	0.14	0.12	—		
Postsecondary Major (STEM or non-STEM)	–0.19	0.17	0.26	0.16	0.28	—

3. Mathematics and science identity were standardized to have a mean of 0 and a standard deviation of 1.

data analysis, we examined descriptive statistics for each variable. We first conducted a correlational analysis to assess any associations between the variables of interest (i.e., gender, math identity, science identity, career expectations at age 30, high school STEM course completion, and postsecondary major [STEM or non-STEM]). We then tested the logistic regression assumptions and conducted a binary logistic regression analysis correspondingly. Specifically, we examined whether the predictor variables, including gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion, can successfully predict a student's postsecondary major (STEM or non-STEM). We used binary logistic regression because the dichotomous and continuous predictors were predicting a dichotomous outcome variable. As a follow-up based on the results of the binary logistic regression, we included gender as a moderator to determine whether gender moderates such relationships.

RESULTS AND INTERPRETATION

The HSLS:09 (NCES, 2009) data set is not a simple random sample of U.S. high school students; specifically, it used a stratified, two-stage random sample design. As a result, analytic weights were included in the data set to ensure the sample data was representative of the population of high school students due to the differential response rates in the sample (Ingels et al., 2013).

Binary Logistic Regression

A binary logistic regression was conducted to examine the relationship between gender, math identity, science identity, career expectations at age 30, high school STEM credit completion, and postsecondary major (STEM or non-STEM) (see Table 5). The overall model was statistically significant ($x^2(5) = 129.62$, $p < .001$) with a small effect size ($R^2 = .20$). Gender significantly predicted the likelihood of postsecondary enrollment in STEM major (Exp(B) = .24, $p < .001$). The odds of female students enrolling in a postsecondary STEM major were .76 less than the odds of male students so enrolling. In other words, female students were less likely to enroll in STEM majors compared to male students. Science identity significantly predicted the likelihood of postsecondary enrollment in STEM majors (Exp(B) = 1.66, $p < .001$). For each standard deviation increase in science identification, BIPOC students had approximately 1.7 times greater odds of majoring in STEM. This result confirms that BIPOC students who "identified more as a STEM person" were more likely to major in STEM. STEM credits

Table 5. Binary Logistic Regression of Demographic and High School Variables Predicting College Major

Source	*Odds Ratio*	*SE*	*p*	95% *CI OR*
Intercept	0.10	0.05	.000	[0.04, 0.25]
Gender	0.24	0.06	.000	[0.15, 0.39]
Math Identity	1.24	0.23	.252	[0.86, 1.77]
Science Identity	1.66	0.20	.000	[1.31, 2.11]
Career Expectations at Age 30	4.77	1.30	.000	[2.80, 8.13]
High School STEM Credit Completion	1.09	0.05	.049	[1.00, 1.20]

completed in high school also marginally predicted the likelihood of postsecondary enrollment in STEM (Exp(*B*) = 1.09, p = .049). For every unit increase in high school STEM credits completed, BIPOC students had approximately 1.09 times greater odds of majoring in STEM. In other words, BIPOC students who completed more STEM credits in high school were more likely to choose a STEM major in college. Expectation of a STEM career at age 30 was significantly predictive of the likelihood of postsecondary enrollment in STEM majors (Exp(*B*) = 4.77, p < .001). BIPOC students who see themselves in STEM occupations at age 30 had 4.77 times the odds of enrolling in STEM majors in postsecondary education than those who do not see themselves in STEM occupations at age 30. The only non-statistically significant relationship found was between math identity and postsecondary enrollment in STEM majors (Exp(*B*) = 1.24, p = .252).

Ad Hoc Analysis

Our team also conducted an auxiliary moderated logistic regression to determine whether gender moderated the relationship between science identity and whether a student majored in STEM in college. These results show that gender, in fact, moderates the relationship between science identity and the likelihood of a collegiate major in STEM, Exp(B) = 1.45, p < .001. For male students, the relationship between STEM identity and the odds of the student majoring in STEM is statistically nonsignificant. For female students, the relationship between STEM identity and odds of the student majoring in STEM is statistically significant, with female students who scored higher on science identity having odds 1.45 times greater for majoring in STEM than female students who scored lower on science identity.

DISCUSSION AND SIGNIFICANCE

Our research seeks to examine variables that influence STEM pathways for BIPOC students. Using the HSLS:09 (NCES, 2009), we examined whether gender, math identity, science identity, career expectations at age 30, and high school STEM credit completion can predict whether a student majors in STEM as an undergraduate. The demographics of our sample of 5,702 participants who identified as American Indian or Alaska Native, Asian, Black or African American, Hispanic, and Native Hawaiian or Other Pacific Islander provided valuable insights into student representation, perceptions, and involvement in STEM throughout high school and college. In this section, we summarize factors influencing students' selection of STEM postsecondary majors within the context of our variables; in addition, we discuss supportive factors toward helping BIPOC students author identity, explore, and participate in STEM fields.

From the logistic regression results, it is shown that gender, science identity, career expectations at age 30, and high school STEM credit completion were all related to BIPOC students enrolling in postsecondary STEM majors. Joining a few emerging studies that identify multileveled factors to foster the persistence of BIPOC students and professionals in STEM fields (see Chemers et al., 2011; Estrada et al., 2018; Merolla & Serpe, 2013), we suggest that the development of STEM identity and career expectation early on for BIPOC students can have an important impact on their college persistence and at the same time be a protective factor when they experience negative stereotypes throughout and beyond college. Our findings contribute to bridging identified gaps in the literature, including the use of large-scaled analyses that follow a student cohort from high school through college (see Hurtado et al., 2010) and that examine longitudinal influences that STEM identity, participation, and expectation cultivated during high school have on college endeavors, including students' decision to major in STEM (Merolla & Serpe, 2013).

Our study emphasizes the importance of early exposure to STEM classes, practices, and career trajectories to disrupt the lack of STEM participation among BIPOC students. We repeat the needs for educators and advocates to address the disparities of access and meaningful learning experiences in STEM, including providing BIPOC students with opportunities and scaffolding that lead to fulfilling STEM credits and building identity in STEM. Our finding also incites more socially situated and integrative learning designs that attend to students who are historically marginalized in this field. Helping students to see themselves in STEM should be an ongoing intentional goal of career counselors, educators, and other professionals who want to increase success and college-going activities for their underrepresented students. Through coursework and extracurricular activities, STEM engagement that facilitates dynamic, meaningful, and accessible experiences can help minority students imagine and see themselves in STEM (Martin-Hansen, 2018; Polman, 2012; Taylor, 2019) in different ways. Furthermore, both formal and informal learning designs aiming to promote STEM identification—including after-school programs, math and science summer camps, and tutoring programs—should go beyond merely focusing on STEM-related knowledge and skills to addressing embedded sociohistorical implications in the learning and development of minoritized students in STEM (Bang & Medin, 2010; Langer-Osuna & Nasir, 2016; McGee, 2021; Vossoughi & Vakil, 2018).

LIMITATIONS AND FURTHER RESEARCH

While weekly discussion involving all team members throughout all processes of the research during a period of six months was beneficial in improving the quality and integrity of our study, our analysis encountered limitations. First, our study suffered a lack of diverse representation within our BIPOC students. Hispanic and Black or African American students make up the majority of the sample (45.5% and 28.3%, respectively) and this means that interpretations and conclusions drawn from this study will largely discuss these groups' experiences. Second, the limitation of the HSLS:09 (NCES, 2009) data set in providing response options that reflect the spectrum of gender identity (Christopher, 2021) constrained our ability to report patterns for students whose gender identity differs from their biological or birth sex. Additionally, our analysis has yet to examine other identity dimensions, including geographical differences, income, age, (dis)ability status, immigration status, linguistic backgrounds, and those dimensions' intersectional influences on BIPOC students' engagement with STEM disciplines. Furthermore, it was our original interest to match students' high school data with corresponding college data, including enrollment, persistence, performance (e.g., GPA, credit hours, and engagement in STEM clubs and organizations), and retention (e.g., career trajectory). Due to the researchers' decision to focus on a smaller number of factors already studied in the literature individually but not collectively, this larger goal remains an area of future opportunities. Recognizing how STEM identities are highly fluid and context specific, we encourage researchers to further investigate other dimensions of identity, beyond race and gender, as well as their longitudinal impacts on BIPOC STEM students.

While the current model is overall statistically significant, the relatively low variance explained by the variables included in the model (R^2 = .20) indicates there are additional factors that should be considered when examining why BIPOC students may or may not major in STEM fields. Specifically, the low variance in the logistic regression result is indicative of there being additional factors that have stronger influences on students' choices. Concomitantly, while our descriptive analysis shows that BIPOC students took at least one STEM course in high school, future research is recommended to examine the level of academic involvement in STEM that translates to BIPOC students identifying with math and science or seeing themselves in STEM careers at age 30. A future study might separate high school STEM credits into math credits and science credits earned during high school. This will help to determine whether the number of credits taken in a specific STEM field is more important in determining college major selection than "STEM credits" broadly. In this vein, a more thorough conceptualization of math identity and science identity (e.g., conceptualizations that take into account varying, intersectional experiences among BIPOC students) may provide a more nuanced understanding of the relationship between student math identity and student science identity, as well as postsecondary enrollment in STEM disciplines.

Our study found BIPOC women were less likely to enroll in STEM majors compared to BIPOC men. This finding is consistent with the literature describing the underrepresentation of BIPOC women in STEM fields and emphasizing their feelings of isolation and exclusion in STEM environments (D. Johnson, 2011; Ong et al., 2018). Prior studies show that gender moderates the relationship between STEM identity and both persistence and academic achievement in STEM (Le et al., 2014; Seyranian et al., 2018). Our findings contribute to the literature by confirming that gender moderated the relationship between science identity and whether a student majored in STEM. Given prior research showing differences in the relationships between self-efficacy, persistence, ability, and STEM outcomes based on gender, future analyses could include gender as a moderator when considering factors influencing STEM-based outcomes among minority students. Without including gender as a moderator, we may misinterpret important findings by considering outcomes as consistent across genders when in fact this may not be the case, as seen in our auxiliary analysis.

CONCLUSION

In closing, our study addresses the shortage of quantitative research illuminating the impact of K–12 experience on BIPOC students in STEM disciplines. Our findings suggest a correlation between gender, science identity, career expectations at age 30, and high school STEM credit completion with postsecondary major (STEM or non-STEM). We recommend integrative ways to support BIPOC students during high school because this critical time shows the potential to impact postsecondary STEM-related outcomes. Furthermore, this research is relevant to STEM educators, career counselors, and other professionals as they explore meaningful ways to create pathways that take into account STEM-identity development and learning environments that make STEM accessible and meaningful to underrepresented students. Our study encourages researchers and practitioners to investigate opportunities to improve STEM participation collegiately and career-wise for BIPOC students. In doing so, we highlight our deliberate decision for using critical quantitative approaches—prioritizing socially responsible and ethical research practice—in analyzing large-scale data sets.

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