INTERSECTIONAL IDENTITY: FACTORS IMPACTING STUDENT ODDS OF FIRST SEMESTER STEM MAJOR DECLARATION

by

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ABSTRACT

Though there is a large amount of literature on those who graduate from college with STEM degrees, there is a dearth of literature involving intersectional identity of college freshman who are considering entering STEM majors. This study seeks to begin the process of meeting the gaps in research. Data from the High School Longitudinal Study of 2009 (HSLS:2009) were analyzed using logistic regression; using listwise deletion, intersectional identities which impact odds of student declaring a STEM major were identified. Student race and ethnicity, student sex, student socio-economic status, teacher race and ethnicity, teacher sex, science utility, science interest, science self-efficacy, and science identity were the components of intersectional identity for this study. Student race, student socio-economic status, science self-efficacy, and science identity were statistically significant factors that increased student odds of entering college with as STEM degree ($p<0.001$). Students who were Asian had a statistically significant increase in odds over White students to enter college with a STEM degree. All other aspects of identity were not statistically significant. More research is needed in this field to gain a deeper understanding of how intersectional identity impacts a students' odds of declaring a STEM majors their first semester in college.

CHAPTER ONE

INTRODUCTION

Background

Colleges are quickly becoming more diverse places for students who have historically been marginalized. In 2010, 32% of Hispanic students, 36% of Pacific Island students, and 38% of students who identified as more than one race and ethnicity represented the three lowest percentages of students by race and ethnicity who attended college (National Center for Education Statistics). In 2020, however, these three groups were the only three demographics by race and ethnicity that increased their enrollment numbers (National Center for Education Statistics, 2022). Simultaneously, students who have historically dominated college enrollment, White and Asian students, had decreases in college enrollment (National Center for Education Statistics, 2022). Excluding Hispanic males, male students have seen a decrease in enrollment (Parker, 2021; National Center for Education Statistics, 2022). While universities have been increasing diversity, there is concurrently a hard to swallow pill: not all majors are increasing their diversity equally.

Statement of Problem

One such subset of majors that continues to lack diversity are science, technology, engineering, and math (STEM) majors (National Science Foundation, 2023). There is a need to understand who is leaving college with a STEM degree; it is also important to understand who is entering college having declared a major in a STEM degree. Examining these two data points will guide future research by showing the difference between the students who declare their degree in STEM their first semester, and the students who ultimately obtain a STEM degree. This knowledge is critical in understanding the potential differential in initial declarations and final outcomes within STEM majors so researchers can begin to find ways to increase the likelihood of historically marginalized students graduating with STEM degrees.

This study looks into potential pathways for increasing diversity in STEM by examining the odds of students entering their first semester having declared an intent to obtain a STEM degree. This is analyzed through the lens of student race and ethnicity, sex, and socio-economic status, of teacher race and ethnicity and sex, and of a students' degree of science connectedness: science identity, science self-efficacy, science interest, and science utility. Ultimately, a picture of student intersectional identity will give a deeper understanding of which factors guide students' decisions to explore STEM majors.

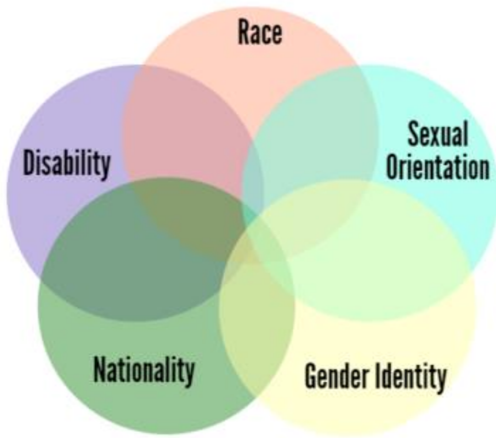
Purpose

While the literature is comprehensive on the inequities that females, students of color, and students from low SES households face in schools and in STEM classrooms, there is a lack of examination of intersectionality in the literature. For example, nearly all contemporary literature looks at sex, race and ethnicity, and SES independently of each other in the context of academics (Carlisle, 2022; Chen et. al., 2019; Egalite et. al., 2015). A lack of student intersectionality exists in the literature, thus creating a partial story of how students' identity impacts academic and career choices. There is a need to understand the full impact of student identity to gain a deeper understanding of all the factors that impact students' decisions to enter STEM. The literature is also inconsistent on how student/teacher race and ethnicity matching and student/teacher gender matching impacts student outcomes. For that reason, there is a continued need for more literature looking at these impacts (Dee, 2004; Price, 2010; Redding, 2019).

In order to gain a deeper understanding of what has the largest impact on students' entering college as a STEM major, there is a need to consider the intersectionality of students. Boston (2017) asserts that "intersectionality is a framework for conceptualizing a person, group of people, or social problem as affected by a number of discriminations and disadvantages. It takes into account people's overlapping identities and experiences in order to understand the complexity of prejudices they face" (para. 5). Intersectionality provides a more profound understanding of how people's identities interact with their environment (Bailey, 2018). In turn, this allows for people to begin to understand the nuances of how and why people's internal and external identities give rise to their actions (Bailey, 2018). This process centers conversations around students whose identity is multidimensional. As Crenshaw (1989) asserts, there are "problematic consequence[s] [with treating] race and gender as mutually exclusive categories" (Crenshaw, 1989, para. 2). Utilizing a framework that examines multiple dimensions of student identity will hopefully lead to more research being performed on how all aspects of identity impact rates of diverse students in more inclusive STEM spaces.

Though the literature shows several studies looking at impacts of intersectionality, the scope of those same studies may be limited (Bauer et. al., 2021). Studies, such as this one (which is quantitative) lack the depth of fully understanding the experiences of people who are multidimensional in their identity (Gendered Innovations, n.d). Because of this understanding that fully expressing impacts of identity produce only a partial understanding of people's experiences for the type of analysis done in this study, social cognitive career theory will be the predominant framework used to investigate the questions posed below. Figure 1 below illustrates a representation of intersectionality.

Figure 1 Representation of Intersectionality



Note. Representation of Intersectionality. From “What is intersectionality and what does it have to do with me?” by YW Boston. Copyright 2017. https://www.ywboston.org/2017/03/what-is-intersectionality-and-what-does-it-have-to-do-with-me/

Theoretical Framework

In order to gain a more profound understanding of the factors that impact student’s rates of entering college having declared a STEM major, this study utilizes social cognitive career theory (SCCT). SCCT is a framework used to identify both intrinsic and extrinsic motivations that inform why people make career decisions (Lent et. al., 1994). The extrinsic factors used in this study are student race and ethnicity, student sex, student socio-economic status, teacher race and ethnicity, and teacher sex; additional use of intrinsic measures of science utility, science interest, science self-efficacy, and science identity creating a deeper understanding of how each component of a student’s identity impact and interact with each other to lead them to desiring a STEM degree.

Race and sex are both key components of extrinsic factors looked at previously to SCCT (Lent, et. al., 1994). The addition of self-efficacy into SCCT is what strengthened the assumptions set forward by the creators of social cognitive career theory. Because of self-efficacy being one of the three pillars of SCCT, the inclusion of self-efficacy, along with utility, interest, and identity, intend to strengthen the assertions of this study as it relates to intrinsic factors that impact students' declaration of STEM majors in their first semester of college.

This study seeks to analyze the cumulative aspects of students' identities to find nuance in the ways in which we talk about rate of students declaring a STEM degree their first semester in college with the intent of graduating with a STEM degree. This may inform how STEM teachers discuss identity labels around scientists, mathematicians, and engineers. It will also aid in who teachers purposefully uplift in their classrooms. Ideally, teachers will spend time to give equal representation to inclusive members of the STEM community, which may improve student self-image and lead to more students of all ages being able to see themselves as people who can exist in and succeed at STEM.

Research Questions

The following research questions guided this study:

1. Does the race and ethnicity, sex, and familial socio-economic status of first-year college students have an impact on their rates of declaring their major as a STEM degree?
2. Does the sex of the last high school science and math teacher that a first-year college student had impact on their rates of declaring their major as a STEM degree?

3. Does being the race and ethnicity of the last high school science and math teacher that a first-year college student had impact on their rates of declaring their major as a STEM degree?
4. Do science utility, science interest, science self-efficacy, and science identity have an impact on first-year college students' rates of declaring their major as a STEM degree?

Limitations

This study examined factors that impacted the odds of students declaring a STEM degree their first semester of college. To do this, data was first obtained for students who went to college. The data were then cut to only ask students if they had or had not started their first semester having declared their major as a STEM major. This method of identifying both excludes students who wanted to go to college, but either opted out or were unable to attend. It also eliminates students who were not declared when this data point was collected. Students who did not respond to the survey were additionally counted as "missing." The removal of these students led to 3,193 students who, at the time of data collection, had declared a major. It led 128 students who identify as American Indian or Alaska Native and 96 students who identify as Native Hawaiian or Pacific Islander.

The race and ethnicity of teachers and students were matched, and the logistic regression was run to determine how much more likely students were to consider going into STEM degrees if they had the same race and ethnicity as their science and math teachers. Because of the lack of teachers who identified as American Indian, Alaska Native, Native Hawaiian, or Pacific Islander, students who identified as any of these races and ethnicities were not counted. The low number of students and teachers who responded to these questions who self-identified as "Hispanic –

race identified" and as "Hispanic–no race specified" led to the two groups being into a single group so the number per group was greater. Students who identified as American Indian or Alaska Native were a small portion of the data used, and no teachers identified themselves as American Indian or Alaska Native. The same is true for students and teachers who identify as Native Hawaiian or Pacific Islander.

One final limitation of this study stems from the understanding that several colleges and universities in the United States do not allow for students to enter college with a declared STEM major, specifically engineering. Schools such as the University of Illinois Urbana-Champaign and the University of Washington require students to attend the university for a minimum of one year before being admitted into the engineering school (University of Illinois, n.d.; University of Washington, n.d.). An inability to declare majors in engineering reduce the number of students who answered "yes" to the High School Longitudinal Study survey used for this study; outcomes for this study will, in turn, be conservative, as not every student who entered higher education has the ability to declare a STEM major their first semester. This means there will be a scarcity of students declaring an engineering degree compared to students declaring science, technology, and mathematics majors.

Delimitations

The data for this study came from the High School Longitudinal Study (HSLS:2009), rather than collecting data personally because of the short timeline available for this study. When data were being analyzed, the original data had two distinct groups for students who were "Hispanic – race specified" and "Hispanic – no race specified." Because both groups had small numbers of participants, the two groups were combined to look for significance for student race and ethnicity. The study also looked at the impact of teacher race and ethnicity for student academic outcomes. The decision was made to measure the impact of teachers/student race and ethnicity matching to look at how students of all races and ethnicities are impacted by teachers of the same or different races and ethnicities. This led to race and ethnicity matching being a binary variable for all student/teacher combinations potentially leading to weaker results as all students either did or did not match their teachers' race and ethnicity.

Definitions

This study utilized the tenants of social cognitive career theory and intersectionality to analyze aspects of student identity in determining rates of entering STEM majors. *Intersectionality* is defined as **"**a framework for conceptualizing a person, group of people, or social problem as affected by a number of discriminations and disadvantages. It takes into account people's overlapping identities and experiences in order to understand the complexity of prejudices they face" (YW Boston, 2017, para. 5). This approach allows for a more nuanced understanding of who students are and what guides their decision making.

In order to fully capture a complete picture of identity, this study uses the lens of *social cognitive career theory*. Social cognitive career theory views an individual's career choice as interplay between "cognitive and interpersonal factors, and between self-directed and externally imposed influences on career behavior" (Lent et. al., 1994, p. 256). SCCT is built on three pillars: self-efficacy, outcome expectations, and personal goals (Lent et. al., 1994). These pillars are all examined in this study.

One component of intersectionality being analyzed is *socio-economic status,* which is defined as: **"**a combination of income, amount and kind of education, type and prestige of occupation, place of residence" (American Psychological Association). The study also explores race and ethnicity. The phrase "*race and ethnicity*" is the chosen term for this study, as compared to the term "race/ethnicity" in order to be more inclusive of the fact that there are several subcategories of all races and ethnicities (Flanagin, et. al., 2021).

Measures for *science self-efficacy* are measured using the definition proposed by Bandura (1997) as "the belief that one can achieve what one sets out to do" (Bandura, 1997, para. 2). Four factors influence the development of self-efficacy: performance accomplishments, vicarious experience, verbal persuasion, and physiological states (Bandura, 1977). For the purposes of this study, science self-efficacy is the belief that one can achieve what one set out to do in the context of a science classroom. This definition was chosen based on the questions in the HSLS instrumentation used to create the measure of science self-efficacy. A full list of questions within the survey measure are located in Appendix A.

Science identity is defined as a students seeing themselves as a scientist, as well as others seeing them as a scientist (Chemers, et. al., 2011; Ingles et. al., 2011). Just as with science self-efficacy, this definition was chosen because of its alignment to the questions asked of students in this study. A full list of questions asked for determining science identity are in Appendix A.

The measure of *science utility* is defined as self-reported importance students feel about science combined with how important it is to their daily lives (Rozek et. al. 2017; Alhadabi, 2021). This definition of science utility was selected because of its alignment with the questions asked during this study to determine the measure of science utility; questions are in Appendix A.

Science interest "reflects the cognitive potential of a student for achievement in the science field" (Alhadabi, 2021, para. 13). The definition of science interest was chosen based on the questions asked to participants in Appendix A. Finally, this study examined factors that impact students' rates of declaring a STEM major their first semester; *STEM* is defined as a combination of educational disciplines of "Science, Technology, Engineering, and Math."

Conclusion

STEM majors typically represent a lack of diversity (National Science Foundation, 2023). Because of this, there is a need to better understand which students in high school have a consider declaring their major as a STEM majors; knowing who wants STEM majors will provide evidence into potential barriers that may not have been discussed in depth. This study also looks to better our understanding of rates of students declaring a STEM major at all post-secondary establishments. While there is evidence of race, sex, socio-economic status, and science self-efficacy impacting students entering community colleges with a STEM degree, this study looked to broaden the scope to include students attending all colleges and universities (Evans et. al., 2020). The inclusion of intersectionality and social cognitive career theory will help lead to a more refined understanding of specific barriers that impede students who may not be represented in STEM currently; identifying these barriers is the first step towards increasing diversity in STEM fields. This chapter identified the need for an intersectional approach in the field of educational STEM research. Chapter two is comprised of a literature review contextualizing the current research into diversity in STEM, the impacts of student race and ethnicity, student sex, student socio-economic status, the impacts of teacher race and ethnicity, teacher sex, and the impacts of science utility, science interest, science self-efficacy, and science identity on STEM majors and STEM jobs.

CHAPTER TWO

LITERATURE REVIEW

Introduction

People who enter STEM fields are predominantly White and male (National Science Foundation, 2023). Understanding why there is a lack of diverse representation in STEM is the first stepping stone to understanding how to increase diversity in these fields. Taking an intersectional approach will provide more profound understandings of which factors hinder or enhance students' rates of declaring a STEM major. The sex of students, the race and ethnicity of students, and the students' socio-economic status are components of identity that have shown a positive impact on student academic outcomes in STEM (Broer et. al., 2019; Fry et. al., 2021; National Science Foundation, 2023). The inclusion of teachers' race and ethnicity will provide evidence for extrinsic factors for students' interest in STEM, which have both shown impacts (Price, 2010; Redding, 2019; Zhu, 2021). Lastly, discovering how connected students feel to STEM through the lens of science utility, science interest, science self-efficacy, and science identity, are a combination of intrinsic and extrinsic factors. The combination of these factors will provide a deeper and more complete understanding of students entering STEM.

Benefits of Diversity in STEM Fields

STEM jobs provide the solutions to many real-world problems. These solutions are often marked by new people providing novel answers to old questions. One of the best ways to do this is to encourage a more diverse group to try to answer the problem. STEM majors and fields have a lack of diversity, with most students and employees in STEM being white and, excluding the medical field, mostly men (Fry et. al., 2021; National Science Foundation, 2023). With real world issues such as climate change, there are critical needs for solutions (United Nations, n.d.). These solutions are likely to be accelerated with increased diversity; within diverse workplaces, there have been reported increases in product quality, innovation, and productivity (Gomez & Bernet, 2019; Geen et. al., 2002; Ilmakunnas & Ilmakunnas, 2011). Therefore, the need for diversity is paramount.

There is a long history of women and people of color in STEM; however, these stories are often censured, leading to a whitewashing of history (Harvard Library, n.d.; Skibba, 2019). This leads to experiments such as the "Draw a Scientist" experiment where "98% of my students named scientists that are white and male, and only 18% of their drawings showed scientists who were women" (Carlisle, 2022, para. 6). If students enter a classroom with a preexisting idea of who belongs in science, perhaps bringing to light the diversity of scientific heroes that exist may increase students' science identity by letting them see themselves in STEM subjects. Increasing representation has been shown to increase the positive self-perspectives of historically disadvantaged people (Arnesen & Peters, 2018). This, in turn, can lead to more people entering STEM; roles of diverse students and workers in STEM will lead to the diversity the field sorely needs, and will accelerate the future technological changes that will begin to solve the toughest questions we are facing.

Teacher Race and Sex

From primary school to higher education, students of color often point to white teachers viewing them negatively (Eaton et. al., 2020; Redding, 2019). Alternately, matching students with teachers of the same race and ethnicity has been shown to increase students' positive self-view as productive members of the classroom as well as academically (Dee, 2004; Egalite et. al., 2015; Redding, 2019). When matched with teachers of the same race and ethnicity, reading and math scores showed a small improvement for white and black students (Dee, 2004; Egalite et. al., 2015; Redding, 2019) as well as a modest positive effect for Asian American and Pacific Island students in math alone (Egalite et. al., 2015). The importance of reading and math scores is shown with a correlated increase in science scores as well (Zhu, 2021). Once students have entered college, matching race and ethnicity showed an increase in Black student retention in STEM degrees, though conflicting results are shown for matching Latinx students with instructors of the same race and ethnicity (Price, 2010; Redding, 2019).

Unlike matching teacher and student race and ethnicity, matching teacher and student gender shows inconsistent results in increasing student academics or feelings of belonging (Chen et. al., 2019; Price, 2010). Gender matching shows an increase in student science identity solely when students are matched with a teacher of their same gender for their first high school science class (Chen et. al., 2019). Even then, the results are not overarching. If students' first science class in high school was biology, all students showed an increase in identifying as a scientist (Chen et. al., 2019). However, for chemistry, only females showed an increase in science identity when gender matching occurs, and in physics no impact is found for any students (Chen et. al., 2019).

Teacher gender can also play a negative role in high schools. Decreases in science identity occur in every science class from negative teacher perceptions of students, and these decreases are even larger if the negative perception is pointed at students whose gender is mismatched from that of the student (Chen et. al., 2019). Though these findings are significant, such negative impacts can be mitigated by female biology teachers when they take part in positive student-teacher interactions such as telling students they do well in science (Chen et. al., 2019). Further, negative impacts on gender matching continue into college: women in STEM majors are less likely to remain in STEM if their instructors are also female (Price, 2010). Though teachers play an integral role in the outcomes of their students, student intersectional identity has a large impact on how welcomed they feel in STEM classrooms and majors (Fauth et. al. 2019). The components of student race and ethnicity and student sex as it pertains to STEM fields must be examined to gain a deeper understanding of their impacts.

Student Sex, Race and Ethnicity

Within the fields of science, technology, engineering, and math (STEM), a discrepancy in who finds themselves with jobs is conspicuous. Workers who are Black and Hispanic are underrepresented, whereas Asian people hold a disproportionate number of STEM jobs (Fry et. al., 2021). Black, Hispanic, American Indians, and Alaska Native citizens only have 26% of all STEM degrees despite making up 37% of the population (National Science Foundation, 2023). Women earn 53% of all STEM degrees (Fry et. al., 2021), however, they only hold 35% of jobs in STEM fields (NSF National Science Foundation, 2023). Luckily, the number of historically disadvantaged people entering STEM degrees and STEM fields began increasing in 2004 (Chen, 2009) and has continued to grow through 2021 (National Science Foundation, 2023). However, waiting to enact change at the college level is likely to continue to skew the number of students who obtain STEM degrees because of the current lack of diversity (National Science Foundation, 2023). Because representation is lacking in higher education, we must first investigate the elementary and secondary schools to begin to make changes that will lead to more diversity in colleges and universities.

At the high school level, students of all races and ethnicities have a desire to graduate college with a STEM degree at similar rates (Ma & Liu, 2015). Once in college, however, many Black and Hispanic students point to microaggression and discrimination, as well as finances, as a barrier to obtaining a bachelor's degree and beyond (Grossman & Porche, 2013; Eaton et. al., 2020; Ma & Liu, 2017). Students who do not remain in STEM majors often cite the reason they left being because of something negative that happened to them related to their STEM field (Ma & Xiao, 2021). These negative experiences were much more likely to occur to women and students of color who are not Asian (Ma & Xiao, 2021). Ma & Liu (2017) point out that if Black students enter college without the barrier of financial instability, they nearly obtain STEM degrees at the same rate as Asian students. In fact, some of the most problematic negative experiences involve bias against people of color and women (Eaton et. al., 2020; Grossman & Porche, 2013; Starr & Simpkins, 2021). Negative biases towards girls in science and math become blatant around 9th grade (Starr & Simpkins, 2021). These biases include students and parents both believing that boys are better at STEM than girls, and parents and their children likely to both hold the same negative biases (Starr & Simpkins, 2021). These same negative stereotypes exist for women entering STEM in college where most indicate similar negative stereotypes towards them in STEM degrees and fields (Kuchynka et. al., 2022; Grossman & Porche, 2013; Eaton et. al., 2020).

The lack of equal representation of diverse demographics begs the question of whether there is a need to reconsider how STEM education is taught. In order to allow for a broader group of students to see themselves as scientists, schools should consider creating STEM education programs that lead to students caring about STEM (Martin et. al., 2021). For students of color, increasing science identity can be done through increasing support in STEM, providing resources for students, as well as opportunities (Rocha et. al., 2023). Supports, such as peer-to-peer or near peer-to-peer mentors showed an increase in the number of students remaining in STEM for both Black and Hispanic students (Huvard et. al., 2020; Kuchynka et. al., 2020). Moreover, Black students see themselves obtaining a STEM degree if they think a STEM degree will help them better their community (Coleman, 2014). Additionally, creating education that shows students succeeding at math could lead to an increase in girls considering entering STEM; many female students point to lack of being good at math as a reason not to enter STEM (Nix & Perez-Felkner, 2019). Additionally, in computer science, a field that is predominantly male, females are up to 42% less likely to want to get a degree in computer science (Fry et. al, 2021; Hamer et. al., 2023). Therefore, schools and classrooms that can create programs that focus on these connections to STEM for students, can begin to undo some of these negative stereotypes by finding ways to make STEM seem attainable to everyone. Creating these connections is an in-school way to get more students interested in STEM; however, barriers outside the school exist that impact the rates of students in STEM as well.

Student Socio-Economic Status

Socio-economic status (SES) is a measure of status which is a combination of "income, amount and kind of education, type and prestige of occupation, place of residence" (American Psychological Association, n.d.). SES has significant overarching impacts on all demographics, and education is no exception. There is a well-established positive association between SES and educational outcomes (Broer et. al., 2019; Lawlor et. al., 2005; Sirin, 2005). Though the magnitude of the effect is unknown (Broer et. al., 2019), the positive effect is found in high schools and in higher education, though the effect seems to lessen in colleges and universities (Suna, 2020; Rodríguez-Hernández, 2020). These educational impacts have also been found in science, math, and language test scores (Liu, 2020).

Specifically, many students identify financial status as a barrier between them and STEM majors (Ball, 2017; Jeffries, 2020). Within computer science majors, students are expected to come to class with technology that many underrepresented populations are not able to afford; this leads to students viewing themselves in a negative way (Ball, 2017; Wolniak, 2023). Negative views, especially internally, decrease student self-esteem and motivation (Wolniak, 2023) which leads to decreases in desire to partake in STEM related activities (Ball, 2017).

Further, students who come from low SES families have been shown to react to high stakes STEM tests with a fear response (Rozek, 2019). Many of the negative outcomes that students have in STEM can be overcome by introducing mindfulness practices into schools (Roeser, 2020). A recent study shows that students who come from households with low SES show greater outcomes from working on emotional regulation that students from higher SES households (Troy et. al, 2017). Teaching students to emotionally regulate within the context of these high stakes STEM tests cuts the failure rates of low SES students by half, which led to results similar to students who came from higher SES families (Rozek, 2019). Such increases in emotional regulation additionally increase student self-esteem (Mouatsou & Koutra, 2023); because self-esteem has such an impact on academics, it is no surprise that increasing STEM scores is more likely to improve student outcomes in STEM (Hsieh & Simpkins, 2022).

Science Identity and Science Self-Efficacy

Student self-esteem is impacted by a students' interest in science, their self-efficacy in science, and self-belief (Hsieh & Simpkins, 2022; Steenbergen-Hu & Olszewski-Kubilius, 2017). Students who show a personal interest in science succeed at a higher rate than students who do not show the same zeal for the subject (Hsieh & Simpkins, 2022). Self-efficacy in STEM compounds personal interest to lead to students who excel in STEM classrooms at a rate above their peers (Kang et. al., 2018; Steenbergen-Hu & Olszewski-Kubilius, 2017; White et. al, 2019; Dahlem, 2023; Murphy & Kelp, 2023). Self-belief also connects to how students perform academically while in high school: higher self-esteem leads to higher GPA in science classes (Hsieh & Simpkins, 2022).

Interest in STEM often comes from parental involvement (Jiang & Simpkins, 2022). Parental involvement is so crucial that students who have parents involved show increased math and science outcomes when compared to students who do not have the same amount of parental support (Liou et. al., 2022). Where several studies have shown students in and after 4th grade declining in math and science, getting students interested in STEM through parental involvement has a mitigating effect on these negative math and science academic outcomes into high school (Jiang & Simpkins, 2022; Liou et. al., 2022). By 9th grade, students with strong math and science motivation are strongly predicted to enter college as a STEM major (Jiang & Simpkins, 2022).

Robinson et. al. (2019) classified science identity as either being high and stable, moderate and slightly increasing, and moderate and declining. Students whose science identity was defined as high and stable had much greater chances of doing better on exams in STEM and remaining in STEM majors (Robinson et. al. 2019). Further, research shows that if females have a positive self-perception of themselves as a scientist, they are more likely to enter STEM; this is true for females of all races and ethnicities (Kang et. al., 2018). This is critical, as the decrease in science interest is much more pronounced for females than male students (Liou et. al., 2022). Additionally, increases in science identity also create an increase in the chances students will enter college with a STEM degree (Chen et. al., 2019). Indeed, achievement in STEM is more strongly predicted by science identity than it is by race and ethnicity, though both play a role (White et. al, 2019).

The variable which mediates science identity and science achievement is science self-efficacy. Self-efficacy, or the belief in one's ability to achieve a particular goal, is influenced by four factors: 1) successful performance accomplishments related to the goal; 2) vicarious experiences of seeing peers successfully attain the goal; 3) verbal persuasion in which a trusted person provides positive feedback related to the goal; and 4) physiological states such as feeling excited as opposed to anxious about engaging in the task (Bandura, 1977). Seeing oneself as a scientist is correlated with internal expectations students have when it comes to completing tasks in STEM classrooms (White et. al, 2019). Such increases in intrinsic belief impacts the physiological state students are in while in a STEM classroom, thus improving both self-efficacy and STEM academic outcomes. (Britner & Pajares, 2006). Increases in science self-efficacy leads to students' interest in STEM increasing as well (Kwon et. al., 2019). Math self-efficacy also increases student interest in technology, engineering, and math (TEM), but shows no relationship to student science self-efficacy (Kwon et. al., 2019).

Investigating how students view themselves in STEM classrooms is the first step in the process of creating a classroom where more students come to learn and to excel. Letting students learn in ways that get them excited to be in the classroom, allowing them to create projects they feel proud of, and setting them up to prove they can succeed in STEM will show students they can be scientists. Pairing this style of learning with the opportunity of allowing students to show others how they approached the solving of science-based problems improve self-efficacy through vicarious experiences; seeing others thrive in a STEM classroom creates a belief within the classroom of being able to succeed in time of struggle (Bandura, 1997). This opportunity to succeed within a STEM classroom, and the ability to grow students' self-efficacy, can also be achieved by teachers providing encouraging positive feedback about student abilities (Bandura, 1977). Using methods such as Project Based Learning (PBL) increases the rates of science ability in classrooms which in turn improves students' science identity (Jiang et. al., 2022). This, too, is true for science inquiry, technological application and mathematical processing (Jiang et. al., 2022). The above classroom techniques, in turn increase science self-efficacy by creating opportunities for performance accomplishments (Bandura, 1977). By creating flexible classroom environments with inquiry-based learning, students prove to themselves that they can do the hard work that scientists can do, which will increase their science identity, their science self-efficacy, and their self-perception of themselves as a member of the STEM community (Jiang & Simpkins, 2022; White et. al, 2019).

Summary

Current literature shows definitive impacts on student race and ethnicity, student sex, and student socio-economic status on STEM academic outcomes and desires to enter STEM majors

(Broer et. al., 2019; Fry et. al., 2021; National Science Foundation, 2023). Findings regarding teacher sex and teacher race and ethnicity show many benefits accompanied by many areas of needed future research (Dee, 2004; Egalite et. al., 2015; Price, 2010; Redding, 2019). Connecting students with STEM simultaneously increases student desire to enter STEM majors and is generally studied through the lens of science self-efficacy and science identity (Hsieh & Simpkins, 2022; Kang et. al., 2018; Steenbergen-Hu & Olszewski-Kubilius, 2017). These factors combine to show how students view themselves in the context of STEM classrooms (Jiang & Simpkins, 2022; White et. al, 2019). This knowledge can be leveraged in order to increase the population of students who are interested in STEM to become more diverse and more inclusive (White et. al, 2019).

Chapter two presented the literature that currently exists that illustrates the impacts of individual components of identity on students' rates of declaring a STEM degree their first semester. Chapter three will discuss the research design and the process for analyzing the data to answer the proposed research questions.

CHAPTER THREE

METHODOLOGY

Introduction

As discussed above, the purpose of this study is to address the gaps in the literature regarding intersectional student identity of first semester college students who have declared STEM majors. This is paramount to increase inclusivity within STEM fields because STEM fields answer real world problems, and more diversity leads to more unique and innovative solutions (Gomez & Bernet, 2019; Geen et. al., 2002). As a result of these gaps in the literature, the research questions below explore these facets of student intersectionality, teacher identity, and students' connection to STEM.

Research Questions and Null Hypotheses

The Research questions, along with their null hypotheses analyzed in this study, are as follows:

Research Question 1: Does the race and ethnicity, sex, and familial socio-economic status of first-year college students have an impact on their rates of declaring their major as a STEM degree?

Ho_1: The race and ethnicity of a student does not have an impact on a students' rates of declaring their major as a STEM degree.

Ho_2: The sex of a student does not have an impact on a students' rates of declaring their major as a STEM degree.

Ho_3: The familial socio-economic status does not have an impact on a students' rates of declaring their major as a STEM degree.

Research Question 2: Does the sex of the last high school science and math teacher that a first-year college student had impact on their rates of declaring their major as a STEM degree?

Ho_4: The sex of the last high school science teacher does not have an impact on a students' rates of declaring their major as a STEM degree.

Ho_5: The sex of the last high school science teacher does not have an impact on a students' rates of declaring their major as a STEM degree.

Research Question 3: Does being the race and ethnicity of the last high school science and math teacher that a first-year college student had impact on their rates of declaring their major as a STEM degree?

Ho_6: Being the same race and ethnicity as the last high school science teacher does not have an impact on a students' rates of declaring their major as a STEM degree.

Ho_7: Being the same race and ethnicity as the last high school science teacher does not have an impact on a students' rates of declaring their major as a STEM degree.

Research Question 4: Do science utility, science interest, science self-efficacy, and science identity have an impact on first-year college students' rates of declaring their major as a STEM degree?

Ho_8: Science utility has no impact on a students' rates of declaring their major as a STEM degree.

Ho_9: Science interest has no impact on a students' rates of declaring their major as a STEM degree.

Ho_{10}: Science self-efficacy has no impact on a students' rates of declaring their major as a STEM degree.

Ho_{11}: Science identity has no impact on a students' rates of declaring their major as a STEM degree.

Population

This study used the High School Longitudinal Study from 2009-2016 (HSLS:2009) to examine factors that increased the odds of high school seniors entering college in a STEM related major (Ingles et. al, 2011). This was a nationally representative sample with more than 23,000 students randomly chosen from 944 schools in California, Florida, Georgia, Michigan, North Carolina, Ohio, Pennsylvanian, Tennessee, Texas, and Washington. For this study, there were 19,222 respondents with 3,193 students having declared a STEM major at the last data collection. 9,682 of the participants were female, 9,537 were male, and 2 did not answer. 128 students identified as American Indian/Alaska Native, 1,758 as Asian, 1,895 as Black/African American, 3,021 as Hispanic, 1,644 as More than one race, 96 as Native Hawaiian/Pacific Islanders. The data used were public-access data from the National Center for Educational Statistics (HSLS:2009).

Variables

The independent variables used for this study are the sex and race and ethnicity of students, socioeconomic status of the parents, and the sex and race and ethnicity of the science and math teachers. Additional independent variables included scales for science identity, science interest, science self-efficacy, and science utility.

The dependent variable is measured by asking students in their first semester of college what their major was. Students indicated whether they were or were not in a STEM major or if they were undeclared/undecided. Students who indicated they were undeclared/undecided for their major were coded as not being in a STEM major. Students who did not apply to college were excluded, as the study sought to determine the impact of identity and science connection on students who went to college and were in a STEM major their first year.

Race and ethnicity for student participants was divided into 7 categories: American Indian/Alaskan Native, non-Hispanic; Asian, non-Hispanic; Black/African American, non-Hispanic; Hispanic; More than 1 race; non-Hispanic; Native Hawaiian/Pacific Islander, non-Hispanic, and White. Race and ethnicity for the last high school math and science teacher of each participant used the same labels as student race and ethnicity, except neither teacher group included teachers who identified as American Indian/Alaskan Native, non-Hispanic or Native Hawaiian/Pacific Islander, non-Hispanic. An additional label was added to race and ethnicity for teachers as "other." Sex for both teachers was a binary choice, with male and female as the only options provided for respondents.

Student/teacher race and ethnicity matching is measured as a binary variable, where students either match their teacher's race and ethnicity or they do not. This method was utilized for both the last high school science and math teacher that each student had. Teacher race and ethnicity was chosen to be measured this way to examine how race and ethnicity matching for students and teachers impacts a students' odds of entering college having declared their major as a STEM major. Unlike teacher race and ethnicity, there was no matching of teacher and student sex. This was chosen because of lack of strong evidence that sex matching impacts students'

STEM outcomes (Chen et. al., 2019; Price, 2010). Rather, the literature points to female science teachers often impacting all students' science identity (Chen et. al., 2019). Having identified this fact led to the models showing potential impacts on students declaring STEM degrees compared to male teachers. Effects would provide evidence of either male or female teachers increasing or decreasing the odds of students declaring STEM degrees. These variables will give a deeper understanding of the internal and external factors that help or impede students in their sojourn towards STEM at a university or college. They will also deepen the understanding of how all aspects of identity interact with each other to create an intersectional model for students entering college.

The components of identity (sex, race and ethnicity, and socioeconomic status) were chosen for both teachers and students because STEM degrees are predominantly held by men and white people (National Science Foundation, 2023). SES was chosen for this analysis because college is historically attended by people who have more financial security (National Center for Educational Statistics, 2015). Using these aspects of identity, as well as additional scales, such as science identity, will hopefully reveal a differential between those who want to attend college and obtain a STEM degree and those who graduate with a degree in STEM. If such a differential is apparent, there will be a need for more research into what causes this discrepancy.

The final variables explored in this study are science identity, science interest, science self-efficacy, and science utility. These four variables were created by the original HSLS researchers from questions that students were asked as high school seniors. Measures for science identity and science self-efficacy were chosen for this study because previous literature looks at how both identity and self-efficacy improves academic outcomes for STEM classes in high school (Hsieh

& Simpkins, 2022; Steenbergen-Hu & Olszewski-Kubilius, 2017). Similarly, science interest and science utility were chosen because the literature makes mention to these measures being mediating factors between identity, self-efficacy, and academic outcome (Kwon et. al., 2019; White et. al, 2019).

In order to gain a deeper understanding of how these two measures mediate academic outcomes, both are included to look for times when either measure may show increases in odds of students declaring their major to be a STEM major. The four measures of science connection will be measured along with race and ethnicity, sex, socio-economic status because of how integral these aspects of identity are to academic outcomes in STEM. An inclusion of these aspects will help distinguish any interplay between identity and connections of science, as measured through identity, self-efficacy, interest, and utility of science. Because the literature points to mixed outcomes for gender matching, while also showing that female teachers can sometimes decrease the academic outcomes in STEM, adding the sex of the last high school science and math teacher will also allow an opportunity to look at the impact that teacher gender has on student outcomes (Price, 2010).

Scoring

Socio-economic status (SES) is a composite measure created using parental or guardian education, occupation, and family income. A single number was then calculated for each student creating their SES score. The minimum value any student could have been given was -8.00 and the maximum value was 2.88. SES is normally distributed. The family SES is used as a continuous variable where the increase in SES correlates with the change in odds that a student says they are in a STEM degree.

Individual's scores for science identity were created using 2 questions. The questions used for this measure were: "Others see me as a science person" and "I see myself as a science person."

Scores for science self-efficacy were created from 4 questions. Examples of these questions are "You are confident that you can do an excellent job on tests in this course" and "You are certain you can master the skills being taught in this course."

Scores for science utility were created using 3 questions which were self-reported on a 1-4 Likert scale. Examples of these questions are "What students learn in this course is useful for everyday life" and "What students learn in this course will be useful for a future career."

Science interest scores were created using 4 questions. 3 questions were self-reported on a 1 to 4 scale, and 1 question was a multiple response question where students were asked to identify their favorite and least favorite class of the day. The full list of questions for all measures is provided in Appendix A.

The questions that the participants answered were 1 to 4 Likert scale questions -- where 1 was coded as strongly agree and 4 was coded as strongly disagree -- and multiple response questions. Individual scores for science identity, science utility, and science self-efficacy were created solely from Likert scales, whereas science interest was created from a combination of Likert scale questions and multiple response questions. The measures for these four variables were created using principal component analysis and participant weights (Ingles et. al., 2011) by the original HSLS researchers. Once each participant had a score for science identity, science utility, science self-efficacy, and science interest, each set of scores was standardized to having a mean of 0 and a standard deviation of 1; all scores were self-reported.

Statistical Methods: Logistic Regression

To explore these variables' impacts on one another, a logistic regression was utilized; this method is defined as "[an] appropriate regression analysis to conduct when the dependent variable is dichotomous (binary)…[and explains] the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables" (Statistics Solution, 2022, para. 1). Because students are being measured on whether they began college having declared themselves a STEM major (or not), logistic regression best predicts the outcomes of the independent variables on the dependent variable. The coefficients for each independent variable on a logistic regression shows the odds of that variable having an impact on the logistic regression outcome compared to a baseline case.

The baseline case for student sex was female students; for student race and ethnicity, the baseline case where white students, and for familial socio-economic status, it was the standardized mean equal to 0. For science and math teacher sex, the baseline was female teachers, and for race and ethnicity the baseline case was student teacher mismatched race and ethnicity. The base case for science identity, science self-efficacy, science interest, and science utility, the base case was the standardized mean equal to 0.

The regression was run using two distinct ways to deal with high numbers of missing data. These two ways were multiple imputations and listwise deletion. Glen (2022) states that "multiple imputation (MI) is a way to deal with nonresponse bias — missing research data that happens when people fail to respond to a survey" (para. 1). To do this, the Stata software identifies all values that are not missing, finds a value that would fit into the preexisting data set without changing the outcome, and then provides that new value to all participants that are missing each measure. Comparatively, "[l]istwise deletion means that any individual in a data set is deleted from an analysis if they're missing data on any variable in the analysis" (Grace-Martin, 2023, para. 1). Listwise deletion was the chosen model used in this study. Though researchers are often dissuaded from using listwise deletion with large numbers of missing data, all listwise regressions had lower Akaike information criterion (AIC) and Bayesian information criterion (BIC). Of the six listwise deletion models, model 6 (described in chapter 4) was chosen as the model with best fit because it was the model with the lowest AIC (6082.107) and BIC (6195.805). The results from multiple imputations are provided in Appendix B for reference. An additional table with each of the research questions run in a logistic regression separately is included in Appendix C for reference as well.

To allow for logistic regression to be run to investigate interactions for all student/teacher race and ethnicity impacts, a new variable was created where students and teachers were coded as 0 if the student and teacher had identified as the same race and ethnicity. The rest of the participants were coded as 1, if the race and ethnicity of the student was not the same as the race of the teacher. This created a binary value which made finding significance possible for all same student/teacher race and ethnicity interactions.

Logistic Models

For this study, the research questions were addressed using six different models of logistic regression. Model 1, which addressed research question one, examined the impact of student race and ethnicity, student sex, and familial socio-economic status. Model 2 added the sex and matching of student/teacher race and ethnicity to the first model and was utilized to answer research questions two and three. Model 3 added science utility to model 2. Model 4 added science interest to model 3. Model 5 added science self-efficacy to model 4, and model 6 added science identity to model 5; models 3-6 were run to answer research question four. Four models were run for the fourth research question because the measures for science identity, science self-efficacy, science interest, and science utility are highly correlated. Because of this, the four measures were run independently of each other to allow for a broader scope of understanding for how all the measures were related. Models 1-6 are included in table 11 in the results section.

Summary

To answer the research questions, logistic regression was used with students entering college as a declared STEM major as the dependent variable. Student sex, student race and ethnicity, student socio-economic status were the independent variables for research question one. Teacher sex for the most recent math and science teacher participants had in college were the independent variables for research question two. Whether a teacher's race and ethnicity of the last science and math teacher for the participants matched the participants' race and ethnicity were the variables for research question three. Finally, science utility, science interest, science self-efficacy, and science identity were the independent variables used to answer research question four.

Logistic regression was run using both multiple imputations and listwise deletion, to address missing data. Listwise deletion was ultimately chosen as the model of best fit, and it also analyzed all variables simultaneously. This strengthens the need for an intersectional approach to studying interest in STEM. The next chapter provides results for the research questions being proposed by this study.

CHAPTER FOUR

RESULTS

Introduction

This chapter shares the results for the proposed research questions enumerated in chapter three. Student sex and student socio-economic status show large impacts on students STEM major declaration ($p<0.001$). Student race and ethnicity, however, only showed impacts for students who are Asian ($p<0.001$). No other student race and ethnicity were significant.

Teacher sex and matching teacher and student race and ethnicity showed no significance either. This finding is present for both math and science teachers.

The intrinsic measures of science self-efficacy and science identity were both significant predictors of students' declaration of a STEM degree as their major ($p<0.001$); however, science utility and science interest did not show significance once science identity was added. This is likely due to science utility and science interested being highly correlated with science identity.

When rate of enter college declaring a STEM major was studied through SCCT, student sex, student socio-economic status, students who identifies as Asian, science self-efficacy, and science identity arose as factors that impact this decision.

Descriptive Statistics

Student Consideration of STEM Majors

In order to understand the factors that impact students who identify themselves as desiring to obtain a STEM degree, the frequency of students considering STEM must first be examined. Table 1 shows the rate of students whose first semester major is in a STEM field. 16.61% of students in the HSLS study identified themselves as having declared their major in their first semester of college as a STEM major. Inversely, 51.24% of high school seniors in the HSLS study said they did not want to go into STEM. These numbers should be considered with caution because of the large number of missing student data; more than 32% of students did not answer this question.

Table 1 - Considering Going into STEM Majors

	Frequency	Percentage	Cumulative
No	9,850	51.24	51.24
Yes	3,193	16.61	67.85
Missing	6,179	32.15	100.00
Total	**19,222**	**100.00**	

Note: Data were collected from the HSLS:2009 data set

Research Question 1: Student Race and Ethnicity, Student Sex, and Socio-economic Status

Table 2 shows the frequency of students who declare a STEM major compared to their sex. For this data, just over 21% of males indicated they were primarily interested in STEM compared to only 12.26% of female students. With 32.15% of data missing, these findings should be considered with caution.

Table 2 - Frequency of Students Declaring STEM Majors by Sex

Student Sex	Male	Female	Missing	Total
No	42.08	60.28	33.33	51.24
Yes	21.03	12.26	0.00	16.61
Missing	36.89	27.46	66.67	32.15
Total	**100.00**	**100.00**	**100.00**	**100.00**

Note: Data were collected from the HSLS:2009 data set

Table 3 illustrates the number of students who were interested in a STEM degree by student race and ethnicity with the percentage within each race and ethnicity.

Table 3 - Frequency of Students Declaring STEM Majors by Race

	No	Yes	Missing	Total
American Indian/Alaska Native,	57	18	53	128
non-Hispanic	(44.53)	(14.06)	(41.41)	(100.00)
Asian, non-Hispanic	746	566	446	1,758
	(42.43)	(32.20)	(25.37)	(100.00)
Black/African American, non-	1,002	222	671	1,859
Hispanic	(49.72)	(11.72)	(35.41)	(100.00)
Hispanic	1,502	369	1,150	3,021
	(49.72)	(12.21)	(38.07)	(100.00)
More than 1 race, non-Hispanic	850	255	539	1,644
	(51.70)	(15.51)	(32.79)	(100.00)
Native Hawaiian/Pacific Islander,	44	12	40	96
non-Hispanic	(45.83)	(12.50)	(41.67)	(100.00)
White, non-Hispanic	5,649	1,751	3,280	10,680
	(52.89)	(16.40)	(30.71)	(100.00)
Total	**9,850**	**3,193**	**6,179**	**19,222**
	(51.24)	**(16.61)**	**(32.15)**	**(100.00)**

Note: Data were collected from the HSLS:2009 data set. Percentages in parentheses.

Asian students have the highest percentage of any race and ethnicity of students who responded having declared their major in STEM degree, at 32.2%. This is nearly double the second highest percentage, which is White students, which showed 16.4% of White high school seniors identify as being interested the most in a STEM degree. Black/African American students have the lowest rates of high school students who want a STEM degree, with only 11.72% of Black students responding that they had declared their degree to be a STEM degree. Nearly every racial/ethnic group has at least 1600 students except for American Indian/Alaska Native and Native Hawaiian/Pacific Island students with 128 American Indian/Alaska Native and 96

Native Hawaiian/Pacific Island. Long (1997) suggests that populations under 100 participants verge on producing risky findings. Long (1997) also suggests the need to run a power series to determine sample size needs). A power analysis was run on the data for race and ethnicity. There were enough Native Hawaiian/Pacific Island students to confidently run statistics without spurious results. However, American Indian/Alaska Native students did not have enough participants. Results for the latter group should be interpreted with caution based on the suggestions of Long and the power analysis.

Table 4 shows the scale scores for student socio-economic status comparing students who entered college declaring a STEM degree. The mean for students who did not enter STEM was 0.183, as compared with students who went into STEM: 0.459. This finding indicates students from higher SES families are more likely to enter STEM majors in college. Findings were found to be significant using a t-test ($p<0.001$)

Table 4 - Scale Scores for Socio-Economic Status for Students Declaring STEM Majors

Socio-Economic Status	Mean	SD	Min	Max
No	0.183	0.766	-1.815	2.567
Yes	0.459	0.818	-1.753	2.567
Total	0.250	0.788	-1.815	2.567
Observations	12,065			

Note: Data were collected from the HSLS:2009 data set.

Research Question 2: Teacher Sex

The frequency of students declaring their major as a STEM major their first semester in college compared to the sex of their last high school math and science teacher is provided in Table 5.

Table 5 - Frequency of Students Declaring STEM Majors Compared to the Sex of Their Last Math and Science Teacher

Math Teacher Sex	Male	Female	Missing	Total
No	51.00	51.62	50.88	51.24
Yes	16.35	16.94	16.34	16.61
Missing	32.65	31.44	32.78	33.26
Total	**100.00**	**100.00**	**100.00**	**100.00**

Science Teacher Sex	Male	Female	Missing	Total
No	52.34	52.25	49.11	51.24
Yes	17.29	17.14	15.40	16.61
Missing	30.37	30.61	35.48	32.15
Total	**100.00**	**100.00**	**100.00**	**100.00**

Note: Data were collected from the HSLS:2009 data set

For math teachers, 16.35% of students indicate interest in going into STEM when the teacher is male, compared to 16.94% of students interested in going into STEM when the teacher is female. For science teachers, 17.29% of students claim they are interested in a STEM major if their teachers are male, and 17.14% of students are interested in a STEM major if their teachers are female.

Research Question 3: Teacher and Student Race and Ethnicity Matching

Table 6 shows the frequency of students who want to go into STEM compared to the race and ethnicity of their math teacher. The HSLS data shows a discrepancy in how often students consider going into STEM based on the race and ethnicity of the teacher they have. When a math teacher was Asian, 20.78% of students indicated declaring their major in a STEM degree. When the math teacher identifies as more than one race and ethnicity, only 11.94% of students are interested in obtaining a STEM, and only 11.26% of students want to go into STEM when their math teacher is Black. Black teachers and teachers who identify as more than one race also have the highest rate of missing data of all teachers. All other races and ethnicities of teachers had a range of 13.49% and 17.02% of students indicating interest in entering college to obtain a STEM degree.

Table 6 - Students Declaring STEM Majors by Last Math Teacher Race and Ethnicity

	No	Yes	Missing	Total
Asian, non-Hispanic	169	69	94	332
	(50.90)	(20.78)	(28.31)	(100.00)
Black/African American, non-	229	51	173	453
Hispanic	(50.55)	(11.26)	(38.19)	(100.00)
Hispanic	258	70	191	519
	(49.71)	(13.49)	(36.80)	(100.00)
More than 1 race, non-Hispanic	91	24	86	201
	(45.27)	(11.94)	(42.79)	(100.00)
White, non-Hispanic	6,442	2,124	3,917	12,483
	(51.61)	(17.02)	(31.38)	(100.00)
Other	13	4	10	27
	(48.15)	(14.81)	(37.04)	(100.00)
Missing	2,648	851	1,708	8,006
	(50.85)	(16.34)	(32.80)	(100.00)
Total	**9,850**	**3,193**	**6,179**	**19,222**
	(51.24)	**(16.61)**	**(32.15)**	**(100.00)**

Note: Data were collected from the HSLS:2009 data set. Percentages in parentheses.

Table 7 shows the frequency of students who want to go into STEM compared to the race and ethnicity of their science teacher. These results are markedly different from the previous table. 20.65% of students showed interest when their teachers identified as more than one race, and for White teachers, 17.35% of students indicated interest in a STEM degree. The lowest percentage of students desiring a STEM degree occurred when teachers identified their race and ethnicity as “other.” This group only had 22 participants, which was an insufficient sample size to determine significance. Black/African American science teachers only had 14.06% of their students indicate a declaration of entering college their first semester with a STEM degree; only teachers whose self-reported race and ethnicity was "other" had lower rates of student indicating STEM major declaration. All other teacher races and ethnicities fell between these extremes.

Table 7 - Students Declaring STEM Majors by Last Science Teacher Race and Ethnicity

	No	Yes	Missing	Total
Asian, non-Hispanic	167	50	88	305
	(54.75)	(16.39)	(28.85)	(100.00)
Black/African American, non-	243	70	185	498
Hispanic	(48.80)	(14.06)	(37.15)	(100.00)
Hispanic	260	81	144	485
	(53.61)	(16.70)	(29.69)	(100.00)
More than 1 race, non-Hispanic	128	51	68	247
	(51.82)	(20.65)	(27.53)	(100.00)
White, non-Hispanic	5,905	1,959	3,425	11,289
	(52.31)	(17.35)	(30.34)	(100.00)
Other	8	2	12	22
	(36.36)	(9.09)	(54.55)	(100.00)
Missing	3,139	980	2,257	6,376
	(49.23)	(15.37)	(35.40)	(100.00)
Total	**9,850**	**3,193**	**6,179**	**19,222**
	(51.24)	**(16.61)**	**(32.15)**	**(100.00)**

Note: Data were collected from the HSLS:2009 data set. Percentages in parentheses.

To fully answer the third question, understanding how the number of students who match the race and ethnicity must be considered. Table 8 shows the number and frequency of students who match and do not match the race and ethnicity of their last math teacher compared to whether they were in a STEM major in their first semester. For participants who match the race and ethnicity of their math teacher 16.11% of these students wanted a STEM degree, as compared with 16.97% of students who wanted to go into a STEM major but did not match the race and ethnicity of their last math teacher.

Table 8 - Declaring STEM Majors Based on Matching the Race and Ethnicity of Last Math Teacher

	No	Yes	Missing	Cumulative
Not Same Race and/or Ethnicity	5,634 (50.00)	1,912 (16.97)	3,722 (33.03)	11,268 (100.00)
Same Race and/or Ethnicity	4,216 (53.00)	1,281 (16.11)	2,457 (30.89)	7,954 (100.00)
Total	**9,850 (51.24)**	**3,193 (16.61)**	**6,179 (32.15)**	**19,222 (100.00)**

Note: Data were collected from the HSLS:2009 data set

Table 9 shows the number and frequency of students who match and do not match the race and ethnicity of their last science teacher compared to whether they were in a STEM major in their first semester. 16.11% of students who wanted a STEM degree also match the race and ethnicity of their last math teacher. This compares to 16.84% of students who did not match the race and ethnicity of their last science teacher.

Table 9 - Declaring STEM Majors Based on Matching the Race and Ethnicity of Last Science Teacher

	No	Yes	Missing	Cumulative
Not Same Race and/or Ethnicity	5,892 (49.25)	2,015 (16.84)	4,056 (33.90)	11,963 (100.00)
Same Race and/or Ethnicity	3,958 (54.53)	1,178 (16.23)	2,123 (29.25)	7,259 (100.00)
Total	**9,850 (51.24)**	**3,193 (16.61)**	**6,179 (32.15)**	**19,222 (100.00)**

Note: Data were collected from the HSLS:2009 data set

Research Question 4: Science Utility, Science Interest, Science Self-Efficacy, and Science Identity

Mean, standard deviations, and minimum and maximum values were calculated for science identity, science, science utility, science, self-efficacy, science interest, and socio-economic status compared to student interest in STEM. Table 10 shows the descriptive statistics for all five dependent variables.

Table 10 - Scale Scores for Science Identity, Utility, Self-Efficacy, and Interest for Students Declaring STEM Majors

Science Identity	Mean	SD	Min	Max
No	0.033	0.972	-1.57	2.15
Yes	0.571	0.962	-1.57	2.15
Total	**0.164**	**0.996**	**-1.57**	**2.15**
Observations	**11,937**			

Science Utility	Mean	SD	Min	Max
No	-0.008	0.962	-3.1	1.69
Yes	0.282	0.931	-3.1	1.69
Total	**0.064**	**0.962**	**-3.1**	**1.69**
Observations	**10,185**			

Science Self-Efficacy	Mean	SD	Min	Max
No	0.028	0.958	-2.91	1.83
Yes	0.463	0.942	-2.91	1.83
Total	**0.136**	**0.972**	**-2.91**	**1.83**
Observations	**10,183**			

Science Interest	Mean	SD	Min	Max
No	0.016	0.973	-2.59	2.03
Yes	0.356	0.981	-2.59	2.03
Total	**0.101**	**0.986**	**-2.59**	**2.03**
Observations	**10,006**			

Note: Data were collected from the HSLS:2009 data set.

The largest mean difference was for science identity. For students who were not interested in STEM, the mean science identity score was 0.033 where the maximum value was 2.15. This compares to students who are interested in STEM who have a mean science identity score of 0.571 where the maximum value was also 2.15. This is a mean difference of 0.538.

The smallest mean difference was found within science utility: 0.290. Students who were interested in a STEM degree had a mean science utility score of 0.282; the mean science utility score for students who were not interested in STEM was -0.008. Science interest and science self-efficacy had values with mean differences between these two. T-tests were run on all four variables compared to student STEM major declaration, all with significant mean difference of $p<0.001$.

Logistic Regression

For all models, the log odds for race and ethnicity were compared to white students, and the log odds for student sex, math teacher sex, and science teacher sex, were compared to females. For model 1, the only race and ethnicity that was significant was for Asian students; family socio-economic status and student sex were also both significant at $p<0.001$. With the addition of teacher race and ethnicity and teacher sex for model 2, still only Asian students, family socio-economic status, and student sex were significant. The log odds for Asian students and for sex both decreased for model 2, but the log odds for family socio-economic status increased slightly.

In model 3, log odds for Asian students decreased but remained significant, family socio-economic status decreased but remained significant, and student sex increased slightly and remained significant. Science utility was also significant at $p<0.001$. In models 4 and 5, all variables that were significant in previous models remained significant, all log odds decreased, but remained significant, and science interest, added in model 4, and science self-efficacy, added in model 5, were each significant when added. Between model 4 and model 5, with the addition of science self-efficacy, science interest decreased in significance from $p<0.001$ to $p<0.05$.

Research Question 1: Student Race and Ethnicity, Student Sex, and Socio-Economic Status

Model 6 shows the increased odds that independent variables have on a student's rate of declaring a STEM degree for student sex, student race and ethnicity, and student familial socio-economic status. The first null hypothesis was partially rejected for student race and ethnicity; Asian students have a 142.8% increase in odds ($p<0.001$) of wanting to obtain a STEM degree compared to White students; no other race and ethnicity is significant. The second null hypothesis was rejected for student sex; male students have a 109.5% increase in odds ($p<0.001$) over students who are female to consider wanting to obtain a STEM degree. The third hypothesis was also rejected for family socio-economic status. A 1 point increase on the socio-economic scale leads to a 33.2% increase in odds of a student wanting to obtain a STEM degree ($p<0.001$)

Research Question 2: Teacher Sex

Model 6 showed no change in odds for students' declaration of first semester STEM major in college compared to the sex of the teacher. The fourth null hypothesis was supported for the sex of the last science teacher participants had. The sex of the last science teacher participants had shown no statistical significance on the odds of students entering college with a STEM degree ($p=0.798$). The fifth null hypothesis was supported, as the sex of the last math teacher showed no statistical significance to the odds of students entering STEM in college ($p = 0.268$).

Research Question 3: Teacher and Student Race and Ethnicity Matching

Model 6 showed no change in odds of students' rates of declaring their major in STEM compared to matching the race and ethnicity for either math or science teachers. The sixth null hypothesis was supported for student/teacher matching of race and ethnicity; matching the race and ethnicity of their last science teacher showed no statistically significant change to the odds of students entering college with a STEM degree ($p=0.554$). The seventh null hypothesis was also supported for student/teacher matching of race and ethnicity for their last math teacher; matching the race and ethnicity for students and their last math teacher showed no statistical significance for students' odds of declaring a STEM major ($p = 0.659$).

Research Question 4: Science Utility, Science Interest, Science Self-Efficacy, and Science Identity

Model 6 shows increased odds of students entering college for science self-efficacy and science identity. The eighth null hypothesis was supported for science utility having an impact on students' rates of declaring their major in STEM; no statistical significance was found for science utility on student STEM declaration odds ($p = 0.113$). The ninth null hypothesis was supported for science interest's impact on a student entering college with a STEM degree. Science interest showed no significant impact on students' rates of declaring a degree in STEM their first semester ($p=0.608$). The tenth null hypothesis was rejected for science self-efficacy impacting a rates of declaring a STEM major in college. A 1 point increase on the science self-efficacy scale leads to a 20.5% increase in odds ($p<0.001$) of students declaring a STEM degree. The final null hypothesis was rejected for science identity; a 1 point increase on the science identity scale coincides with a 46.0% increase in odds ($p<0.001$) of students declaring a STEM major. Table 11 shows all six models with results.

Table 11 - Logistic Regression (Showing Odds Ratios) of Students Entering College Having Declared a STEM Degree Using Listwise Deletion

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Race (reference = White)						
American Indian/Alaska	1.424	1.232	1.175	1.141	1.160	1.178
Native, non-Hispanic	(0.573)	(0.528)	(0.506)	(0.493)	(0.504)	(0.518)
Asian, non-Hispanic	2.850***	2.487***	2.245***	2.279***	2.280***	2.428***
	(0.271)	(0.423)	(0.386)	(0.394)	(0.397)	(0.427)
Black/African American,	0.961	0.845	0.794	0.807	0.772	0.868
non-Hispanic	(0.120)	(0.153)	(0.144)	(0.148)	(0.142)	(0.162)
Hispanic	1.018	0.894	0.873	0.891	0.884	0.967
	(0.105)	(0.151)	(0.148)	(0.152)	(0.152)	(0.168)
More than 1 race, non-	1.241	1.081	1.038	1.060	1.030	1.069
Hispanic	(0.138)	(0.196)	(0.190)	(0.195)	(0.191)	(0.199)
Native Hawaiian/Pacific	1.15	1.006	1.002	1.021	0.987	1.101
Islander, non-Hispanic	(0.521)	(0.479)	(0.475)	(0.485)	(0.469)	(0.524)
Family Socio-Economic	2.266***	1.454***	1.441***	1.430	1.39***	1.332***
Status	(0.141)	(0.059)	(0.059)	(0.059)	(0.057)	(0.056)
Male	1.452***	2.264***	2.283***	2.238***	2.099***	2.095***
(reference = female)	(0.059)	(0.141)	(0.143)	(0.141)	(0.134)	(0.134)
Male Science		0.985	0.989	0.980	0.999	1.017
Teacher		(0.062)	(0.062)	(0.062)	(0.064)	(0.065)
Male Math Teacher		1.064	1.067	1.070	1.076	1.074
(reference = female)		(0.067)	(0.068)	(0.069)	(0.069)	(0.070)
Student/Teacher of Same		0.930	0.934	0.951	0.933	0.944
Race (Math)		(0.118)	(0.120)	(0.122)	(0.121)	(0.123)
Student/Teacher of Same		0.920	0.917	0.914	0.906	0.931
Race (Science)		(0.109)	(0.109)	(0.109)	(0.108)	(0.113)
Science utility			1.356***	1.210***	1.150***	1.067
			(0.046)	(0.047)	(0.046)	(0.043)
Science interest				1.247***	1.107***	1.022
				(0.048)	(0.045)	(0.043)
Science self-efficacy					1.356***	1.205***
					(0.053)	(0.050)
Science identity						1.460***
						(0.058)
Constant	0.167***	0.189***	0.185***	0.180***	0.183***	0.162***
	(0.010)	(0.031)	(0.030)	(0.029)	(0.030)	(0.027)
Observations	6,030	6,030	6,030	6,030	6,030	6,030
AIC	6390.458	6396.465	6313.837	6281.97	6223.97	6134.754
BIC	6450.789	6483.623	6407.7	6382.538	6331.242	6248.73

Note: Data were collected from the HSLS:2009 data set *p<0.05, **p<0.01 ***p<0.001

Conclusion

This chapter provided the results for the proposed research questions. Student race and ethnicity was significant for only Asian students, student sex and socio-economic status were both highly significant ($p<0.001$). Neither the math nor the science teacher sex was significant; teacher race and ethnicity matching were also insignificant for either recent math or science teachers.

Science self-efficacy and science identity were both significant at $p<0.001$, but science utility and science interest lacked statistical significance. Lack of significance for race and ethnicity may be due to small sample size for nonwhite students and teachers or because of highly correlated variables.

The final chapter discusses implications and providing recommendations for future research and educational approaches to help increase diversity in STEM.

CHAPTER FIVE

DISCUSSION

Introduction

The National Center of Educational Research states that approximately 18% of high school graduates enter college with a STEM major (National Center for Educational Statistics, 2019). In this study, several factors including sex and race and ethnicity of students were identified as having an impact on students entering college with a major in STEM. Many of these factors are supported by the previous literature in this field (Hamer et. al., 2023; National Science Foundation, 2023). This research indicated that students who identified as Asian American had much higher odds of having declared their major in STEM by their first year of college. Males had a 109.5% increase in odds of entering college with a STEM degree than their female counterparts.

Additionally, students with higher family socio-economic status had significantly higher odds of entering college declared as a STEM major than students with low family socio-economic status. Finally, strong significant results were found for both science identity and science-self efficacy ($p<0.001$), though components such as student race and ethnicity showed little significance outside students who were Asian. The implications of these findings illustrate the nuance of student intersectionality as it pertains to social cognitive career theory that must be considered to fully understand impacts of outside factors on the rates of students to enter college having declared a STEM major. Both students' extrinsic factors and intrinsic motivating factors play a role that mirrors academic outcomes.

Research Question 1: Student Race and Ethnicity, Student Sex, and Socio-Economic Status

The results for the first research question were varied. If students identified as Asian American, the odds of them entering college declared as a STEM major increased 143% when compared to white students ($p<0.001$). No other race and ethnicity of students had significant findings. Student sex showed a large increase in log odds for males over females for declaring STEM as their major ($p<0.001$), and socio-economic status additionally showed large increases in log odds ($p<0.001$). The lack of significance for students of all other races and ethnicities may have been due to two factors. Because the only significant result for this data in the race and ethnicity category was for Asian students, there is a need to compare outcomes in this study to outcomes in colleges and universities. Asian students attend colleges at higher rates than any other racial or ethnic group (National Science Foundation, 2023). Asian students also obtain STEM degrees at a higher rate than any other racial or ethnic group (National Science Foundation, 2023). A significant finding for Asian students–and only Asian students-- may point to a large discrepancy in students attending colleges, where certain racial and ethnic groups, such as Asian and White students, are so overrepresented in STEM academia, that significant results may only be expected from these two racial and ethnic groups. An additional factor that student race and ethnicity did not show significance may have been because of the interaction between race and ethnicity and socio-economic status.

Research Question 2: Teacher Sex

Findings for the second research question were not significant; These results support the inconsistent findings present in previous literature showing impacts of teacher sex had on students’ rates of declaring a STEM major their first semester in college. (Chen et. Al., 2019; Dee, 2004; Egalite et. Al., 2015; Redding, 2019).

Research Question 3: Teacher/Student Race and Ethnicity Matching

The race and ethnicity of the teacher showed no change to the odds of students’ chances of entering college and declaring themselves a STEM major their freshman year. Because there is relatively strong evidence from the literature that race and ethnicity matching for students and teachers has mostly positive impacts on student academic outcomes in STEM, these results are surprising (Dee, 2004; Egalite et. Al., 2015).

No teachers identified as American Indian or Alaska Native or Native Hawaiian or Pacific Islander, which made it impossible to compare students and teachers from these races and ethnicities. This disparity is likely due to the fact that a large majority of teachers in the United States are White (USA Facts, 2023). Lack of diversity in schools is likely to lead to lack of significance for this study because students and teachers were matched on race and ethnicity. If students are less likely to be matched with a teacher of their race and ethnicity, then not only are students less likely to see themselves represented in a classroom, but they are also more likely to continue to observe science and math teachers are predominantly being White.

Research Question 4: Science Utility, Science Interest, Science Self-Efficacy, and Science Identity

The last research question also provided varied results. When examining the measures for science identity, science self-efficacy, science interest, and science utility individually, each scale was significant at $p<0.001$. The introduction of science self-efficacy led to a decrease in the significance of science interest ($p<0.05$), and the introduction of science identity led to science interest and science utility no longer being significant.

This study did exhibit differences in outcomes as it pertained to science utility from previous literature. Nearly all existing literature looks at the importance of science identity and science self-efficacy; these measures are often discussed in terms of self-esteem, science interest, and science ability (Hsieh & Simpkins, 2022; Steenbergen-Hu & Olszewski-Kubilius, 2017). However, this study showed significant findings for science utility for all models that did not include science identity.

The measures relating to science identity, science self-efficacy, science interest, and science utility are highly correlated with the strongest correlation being between science identity and science self-efficacy ($r = 0.5067$). This is most likely because students who believe in their ability to do science well are more likely to say they see themselves as a scientist (Kang et. al., 2018; Steenbergen-Hu & Olszewski-Kubilius, 2017). Science utility, science interest, and science self-efficacy were all significant on their own. With the introduction of science identity, science utility and science interest were no longer significant, due to being highly correlated. Future research should look at decoupling these scales or creating new scales that may produce fewer overlaps in outcomes for the four above measures.

Systemic Educational Implications

Increasing Representation and Diversity in STEM

Though there was little significance in the findings of this study for race and ethnicity of either students or teachers, there is a need for more diversity within the K-12 educational system. The low number in both students and teachers who were non-white points to inequity within the educational system. While 59% of people living in the United States are White, nearly 79% of teachers are White (USA Facts, 2023). This finding informs potential outcomes for this study. If a majority of teachers are White, the chances of students of color being the same race and ethnicity of their teachers decreases significantly. Increasing diversity in schools, therefore, is a key component to improving student outcomes. This may be done in a top-down model. Principals who are not white tend to hire teachers who are the same race or ethnicity as themselves at a 1.9-2.3% higher likelihood than their white counterparts (Bartanen & Grissom, 2021). Increasing staffing for a more diverse group of teachers removes a potential barrier by allowing more students to see themselves as scientists. Because science identity has the largest potential impact of the science connected scales, allowing students to be able to see themselves in the school system is a step towards increasing science identity and in turn, rates of students in STEM (Chen et. al., 2019).

Science identity could also be increased by changing the approach that science is taught in classes and the people that are taught about during science classes. The importance of representation is key for students (Arnesen & Peters, 2018). By centering the conversation of science around people who are historically marginalized in STEM fields, more students will see themselves as scientists, will connect with the topics more, and will be interested in pursuing fields that are related to STEM (Rainey, et. al., 2018). This implies that teachers of science and math classes spending time to find an intersectional group of people who are in STEM and teach the stories of these people in the classroom may lead to more marginalized students seeing themselves in STEM (Clements et. al., 2022).

Systemic classroom changes may need to begin with students at much younger ages. While this study examined how aspects of identity impact students' odds of declaring a STEM major their first semester of college, creating inclusive programs for younger students may be the direction for future research. This need for inclusive STEM education is due, in part, to the evidence showing nearly 65% of students identify interest in STEM before entering middle school (Maltese & Tai, 2009).

Changes to STEM education programming may also lead to more equity within the classroom by increasing the perception of the importance of diversity in schools. This paradigm shift leads to more students feeling welcomed in STEM fields and classrooms (Cerda-Smith et. al., 2023). This is most effectively done through mentoring programs, where studies illustrate that students who historically have been underrepresented in STEM showed increased feelings of belonging (Kricorian et. al, 2020). This, in turn, increases the odds of students obtaining STEM degrees (Kricorian et. al, 2020). Mentoring can be successful for one-on-one models (Kricorian et. al, 2020) as well as in a cohort model (Gibson et. al., 2020). This type of program may additionally decrease barriers within schools of student view of belonging (Kricorian et. al, 2020). Moreover, creating classrooms where students feel seen can be done through teaching culturally responsive education to teachers (O'Leary, 2020). Teachers who have been taught how to teach diverse groups of students point to understanding their students' struggles more, reframing their negative views of students to being more positive, and even change their teaching to be more accepting of a diverse group of students (O'Leary, 2020). This allows for more students feeling welcomed and seen in STEM classrooms which leads to higher rates of students wanting to succeed and becoming successful (Kang et. al., 2018; Robinson et. al. 2019).

Removal of Financial Barriers

For the HSLS data, SES is calculated ascertaining the occupation, highest level of education, and income of the parent or guardians of each student participant. Values were created through imputing the data set and creating an average measure for each student (Ingles, 2011). This study found the impact of socio-economic status on students' final outcomes to enter STEM majors was a 33% increase in odds of students going into STEM majors per one point increase in family SES. A one-point increase is calculated through a combination of the above parental or guardian’s measures. Because of this, steps must be taken to remove barriers in classrooms to students who come from low SES households. This can be addressed by creating programs where students are given the materials they need to succeed, thus reducing the money needed to access the technology that is needed to succeed. A reduction in equipment needed will simultaneously reduce the stigma that many students feel towards lack of financial resources (Ball, 2017).

Motivating student interest in STEM can be done both inside and outside of classrooms . Creating after school or summer programs that allow students to get hands-on experience is needed; making these programs available to everyone, regardless of income, will help to increase the diversity in STEM (Saw et. al., 2019). In schools, opportunities such as the Science Olympiad could be funded through grants for schools or students who come from low SES to lessen the discrepancy between those students whose families are of higher socio-economic status and those with lower socio-economic status. Removing the financial barrier for students can be one of many ways schools can begin to create a non-exclusionary space for all students regardless of means; however, funding for programs of this category have broad implications in the education field.

Beyond the obvious barrier, which is lack of money, students from low socio-economic backgrounds encounter additional hurtles while entering STEM spaces. When researchers look at STEM attainment through the lens of social cognitive career theory, there is evidence of lack of opportunities from students whose family are lower socio-economic status that others (Yerdelen, 2016). Students from low socio-economic status backgrounds indicate lack of knowledge of STEM careers as well as a dearth of supports from adults to inform students of opportunities in STEM (Yerdelen, 2016).

Adult knowledge and support comes predominantly from parental involvement. Unfortunately, socio-economic status is also correlated with parental support (Turner et. al., 2019). Lack of support produces lack of opportunities for students; academic outcomes fall with lack of parental support as well (Brock, 2010). This may, in part be due to the fact that 15% of employed individuals have more than one job, thus reducing time to help their children with school work or to take them to afterschool programs (Board of Governors of the Federal Reserve System, 2017).

Students from low socio-economic families may also be burdened with needing to work or take care of younger siblings while their parents are at a second job. Ultimately, coming from low SES backgrounds increases the rates of trauma that students undergo; trauma in turn leads to lowering of student achievement. (Hatch et. al., 2007; Larson et. al., 2017). Understanding these barriers is paramount to the creation a more equitable classroom and learning environment. Teachers should spend time to create trauma-informed classrooms to impower all students. There should also be a push for more trauma informed education for teachers everywhere. Creating these climates for all students, and understanding where all students are coming from, should continue to guide and change the ways researchers examine underrepresented populations, such as low socio-economic status students, in STEM.

Recommendations for Future Research

Many gaps exist within the literature as it relates to high school education and STEM education; little is known about the desires of high school students pertaining to their future. There is also a dearth of knowledge about the rates of students who begin in college degrees versus those who graduate college with certain degrees. Though this study found impacts of SES, student sex, and science identity and science self-efficacy on students' overall odds of entering college with a STEM degree, many of the factors, such as the measures for science identity, science self-efficacy, science interest, and science utility should be studied separately. Moreover, the overlap between the science connectedness scales requires further investigation.

Further, intersectional identity needs to be studied as it pertains to the rates of students enrolling in STEM. While research indicates that Black and Hispanic students are less likely to enter STEM majors, the literature also shows that women are less likely to enter STEM (National Science Foundation, 2023). Researchers need to spend time examining how these individual aspects of identity impact the rates of Black and Hispanic females in STEM as well. Looking at STEM majors and STEM fields through the lens of intersectionality will allow for a more profound understanding of which aspects of science identity and science self-efficacy lead to more students desiring to enter college to obtain a STEM degree.

STEM programs should work to be as inclusive as possible; this requires creating spaces for students of all identity groups. While this study analyzed the impacts of the race and ethnicity, sex, and socio-economic status of students, student identity is wider in scope than just these components. For instance, students who identify as being lesbian, gay, bisexual, transgender, and other queer identities (LGBTQ+) are 7% less likely to remain in STEM degrees than non LGBTQ+ students (Hughes, 2018). Creating opportunities in STEM classrooms for students who are LGBTQ+ may potentially help these students see themselves in STEM, thus increasing the diversity in STEM even more. More research needs to be performed regarding the intersectional aspect of student identity. Though this study examined multiple components of identity, gaps exist at the intersection of self-efficacy, identity, interest, and utility. While SCCT includes the impacts of self-efficacy, and both identity and self-efficacy influence utility, few studies have looked to parse out the different components of each of these measures. Because of how highly correlated all measures of self-efficacy, identity, interest, and utility are, delving deeper into the differences in these measures will create a more profound depiction of which components of these measures overlap, and which do not. It is at this intersection where more research must be conducted to understand the full scope of impacts on students entering STEM.

Finally, while representation is important, there is a lack of understanding of which kinds of representation have positive impacts and which have negative impacts (Ertl et. al., 2017; Rainey et. al., 2018). Studies analyzing whether students who learn about diverse groups of people could be performed by providing teachers with a short informational curriculum on diverse scientists, followed by a short activity where the students connect the scientist to the advancement they created. In doing so, the hope is that students may see themselves represented, and representation will increase science identity (Rainey et. al., 2018). Once students see themselves represented in STEM classes and fields, research indicates the chances those same students will want to go into STEM increases as well (Hsieh & Simpkins, 2022; Steenbergen-Hu & Olszewski-Kubilius, 2017).

Conclusion

People do not live in a vacuum, and identities interact. Both family socio-economic status and sex were large factors impacting students' odds of going into STEM; this finding is fully supported in the literature (Broer et. al., 2019; Lawlor et. al., 2005; Sirin, 2005; Starr & Simpkins, 2021). Specifically, recent research indicates that males hold 65% of jobs in STEM and White people hold 64% of jobs in STEM; the lack of Black, Hispanic, and Native American/Alaska Native people in STEM is also concerning (National Science Foundation, 2023). These statistics also have connections to socio-economic status as well, as is evident by the fact that people who identify as these races and ethnicities are more likely to live in poverty (Gupta et. al., 2019; Noel, 2018). This potential interplay may be a reason for lack of significant findings for race and ethnicity in this study. Decoupling race and ethnicity and SES is difficult, so therefore, finding significant results may also be a challenge.

This study also explored the relationship that race and ethnicity matching and sex matching between students and teachers has on the rates of students declaring their major as a STEM major their first semester of college. Both this study, as well as the literature, have shown mixed results for both matching race and ethnicity and matching sex between students and teachers (Chen et. al., 2019;Fauth et. al. 2019; Zhu, 2021). Though the literature shows positive correlations between Black, Asian, and White student race and ethnicity matching with teachers, this study examined the general trends of race and ethnicity matching for all races and ethnicities (Zhu, 2021). Because of this, inconsistency was expected.

Conflated results in the literature and in this study indicate a need for deeper looks into how all aspects of identity interplay with each as it pertains to entering STEM majors and fields. This will allow for a more insightful conversation into how future studies should explore these and other factors impacting college enrollment that will increase diversity in STEM. Overall, a more intersectional look into the components of student identity may provide guidance to schools and future researchers to create more spaces for inclusion in STEM fields.

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APPENDICES

APPENDIX A

QUESTIONS USED TO CREATE SCALES FOR SCIENCE UTILITY, SCIENCE INTEREST, SCIENCE SELF-EFFICACY, AND SCIENCE IDENTITY

Science identity:
How much do you agree or disagree with the following statements:

1. Others see me as a science person
2. I see myself as a science person

Science self-efficacy:
How much do you agree or disagree with the following statements:

1. You are confident that you can do an excellent job on tests in this course
2. You are certain you can understand the most difficult material presented in the textbook used in this course
3. You are certain you can master the skills being taught in this course
4. You are confident that you can do an excellent job on assignments in this course

Science utility:

1. What students learn in this course is useful for everyday life.
2. What students learn in this course will be useful for college.
3. What students learn in this course will be useful for a future career.

Science interest:
How much do you agree or disagree with the following statements:

1. You are enjoying this class very much
2. You think this class is a waste of your time
3. You think this class is boring

Not including lunch or study periods, what is your favorite school subject? Not including lunch or study periods, what is your least favorite school subject?

- You really enjoy science
- You like to be challenged
- You had no choice, it is a school requirement
- The school counselor suggested you take it
- Your parent(s) encouraged you to take it
- A teacher encouraged you to take it
- There were no other science courses offered
- You will need it to get into college
- You will need it to succeed in college
- You will need it for your career
- It was assigned to you
- Some other reason
- You don't know why you are taking this course

APPENDIX B

MULTIPLE IMPUTATIONS LOGISTIC REGRESSION OF STUDENT DECLARATION OF ENTERING COLLEGE WITH A STEM DEGREE

Multiple Imputations Logistic Regression Of Student Declaration Of Entering College With A Stem Degree

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Race (reference = White)						
American Indian/Alaska Native, non-Hispanic	1.400 (0.329)	1.354 (0.320)	1.272 (0.306)	1.280 (0.306)	1.306 (0.316)	1.301 (0.320)
Asian, non-Hispanic	2.302*** (0.157)	2.227*** (0.181)	2.036*** (0.168)	2.054*** (0.171)	2.102*** (0.176)	2.131*** (0.180)
Black/African American, non-Hispanic	1.031 (0.074)	1.001 (0.082)	0.941 (0.079)	0.950 (0.0795)	0.951 (0.081)	1.026 (0.088)
Hispanic	1.106 (0.0711)	1.072 (0.082)	1.044 (0.081)	1.056** (0.082)	1.079 (0.084)	1.133 (0.090)
More than 1 race, non-Hispanic	1.109 (0.089)	1.073 (0.095)	1.034 (0.093)	1.043 (0.094)	1.039 (0.094)	1.038 (0.095)
Native Hawaiian/Pacific Islander, non-Hispanic	1.018 (0.321)	0.983 (0.312)	0.971 (0.308)	0.979 (0.314)	0.975 (0.314)	1.013 (0.328)
Family Socio-Economic Status	1.526*** (0.043)	1.528*** (0.043)	1.514*** (0.043)	1.494*** (0.044)	1.443*** (0.042)	1.380*** (0.040)
Male (reference = female)	2.451*** (0.104)	2.450*** (0.103)	2.476*** (0.106)	2.443*** (0.105)	2.307*** (0.101)	2.301*** (0.102)
Male Science Teacher		1.024 (0.054)	1.026 (0.056)	1.018 (0.056)	1.032 (0.057)	1.045 (0.056)
Male Math Teacher (reference = female)		0.995 (0.049)	0.999 (0.050)	1.003 (0.0500)	1.010 (0.051)	1.013 (0.052)
Student/Teacher of Same Race (Math)		1.016 (0.061)	1.017 (0.061)	1.028 (0.062)	1.033 (0.063)	1.033 (0.064)
Student/Teacher of Same Race (Science)		0.931 (0.057)	0.920 (0.058)	0.913 (0.057)	0.912 (0.057)	0.908 (0.057)
Science utility			1.340*** (0.035)	1.190*** (0.034)	1.125*** (0.033)	1.050 (0.031)
Science interest				1.267*** (0.035)	1.337*** (0.038)	1.038 (0.032)
Science self-efficacy					1.134*** (0.033)	1.188*** (0.036)
Science identity						1.468*** (0.040)
Constant	0.158*** (0.007)	0.162*** (0.011)	0.161*** (0.011)	0.159*** (0.011)	0.158*** (0.011)	0.149*** (0.011)
Observations	19,222	19,222	19,222	19,222	19,222	19,222
AIC	20279.459	20279.294	20041.341	19927.356	19755.383	19432.608
BIC	20350.233	20381.524	20151.434	20045.314	19881.204	19566.293

Note: Data were collected from the HSLS:2009 data set *p<0.05, **p<0.01 ***p<0.001

APPENDIX C

LISTWISE DELETION LOGISTIC REGRESSION OF STUDENT DECLARATION OF ENTERING COLLEGE WITH A STEM DEGREE WITH RESEARCHER QUESTIONS STUDIED INDEPENDENTLY

Listwise Deletion Logistic Regression of Student Declaration of Entering College with a STEM Degree using Multiple Imputations (Research Questions Studied Independently)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Race (reference = White)							
American Indian/Alaska Native, non-Hispanic	1.426 (0.578)						1.193 (0.528)
Asian, non-Hispanic	2.850*** (0.272)						2.448*** (0.433)
Black/African American, non-Hispanic	0.966 (0.121)						0.875 (0.164)
Hispanic	1.015 (0.105)						0.973 (0.169)
More than 1 race, non-Hispanic	1.243 (0.139)						1.073 (0.201)
Native Hawaiian/Pacific Islander, non-Hispanic	1.218 (0.556)						1.155 (0.554)
Family Socio-Economic Status	1.448*** (0.059)						1.328*** (0.056)
Male (reference = female)	2.304*** (0.143)						2.128*** (0.137)
Male Science Teacher		0.995 (0.060)					1.011 (0.065)
Male Math Teacher (reference = female)		1.039 (0.064)					1.074 (0.070)
Student/Teacher of Same Race (Math)		0.886 (0.083)					0.938 (0.123)
Student/Teacher of Same Race (Science)		0.847 (0.080)					0.945 (0.115)
Science utility			1.398*** (0.045)	1.224*** (0.0460)	1.149*** (0.044)	1.059 (0.042)	1.067 (0.044)
Science interest				1.30*** (0.0480)	1.111** (0.044)	1.016 (0.042)	1.024 (0.043)
Science self-efficacy					1.471*** (0.056)	1.29*** (0.052)	1.204*** (0.050)
Science identity						1.51*** (0.058)	1.451*** (0.058)
Constant	0.169*** (0.010)	0.389*** (0.022)	0.32*** (0.010)	0.31*** (0.010)	0.29*** (0.010)	0.27*** (0.009)	0.164*** (0.028)
Observations	6,030	6,030	6,030	6,030	6,030	6,030	6,030
AIC	6331.136	6778.718	6682.686	6633.60	6530.739	6415.52	6082.107
BIC	6391.329	6812.241	6696.095	6653.71	6557.557	6449.04	6195.805

Note: Data were collected from the HSLS:2009 data set *p<0.05, **p<0.01 ***p<0.001