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The Impact of Socioeconomic Status On the Development of STEM Identity, Choice, and Persistence

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THE IMPACT OF SOCIOECONOMIC STATUS ON THE DEVELOPMENT OF STEM IDENTITY, CHOICE, AND PERSISTENCE

by

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Abstract

This mixed-methods study seeks to investigate the direct effect that socioeconomic status (SES) has on a student's identity, choice, and persistence in science, technology, engineering, and math (STEM). There is a diversity and wage gap among the STEM workforce, which is comprised largely of White males with higher salaries than their counterparts. Underrepresented minority groups (URMs) are more likely to come from low SES and typically have fewer educational resources. Identifying the relationship of SES across student groups can yield insights about how to address inequitable practices and increase STEM diversity. Quantitative data was collected via a STEM survey, which was coded for identity, choice, and persistence (criterion variables). Regression analysis of the criterion variables was performed using Pell eligibility and food security status as predictor variables for SES. Qualitative data was collected during focus-group interviews, which were transcribed and analyzed for themes related to the research questions. This study discovered that SES was not influential in the development of STEM identity or in students' choice to pursue a STEM education. However, SES was found to be an important determinant for college choice. Factors that were important for STEM identity, choice, and persistence were family, interest, academic experiences, recognition, and altruism. These factors can be positively affected with the development and implementation of sustainable P-20 programs and incentives aimed at improving academic experiences and fostering strong relationships for students who may be at risk due to demographic factors such as low SES. Improving these factors can influence STEM identity development, thus increasing the probability of student choice and persistence in STEM.

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Chapter I: Introduction

The demand for science, technology, engineering, and mathematics (STEM) jobs have dramatically increased over the last decade, and the outlook for job growth is positive. There is a need for greater diversity among the STEM workforce. Diversity can be defined by the presence of heterogeneity in a population (i.e., gender, race, ethnicity, socioeconomic status, disability status, and other factors) (Rollins, 2020). Heterogeneous teams in the STEM workforce can exceed the productivity and problem-solving abilities over homogenous teams. A study by Hong and Page (2004) implies this is a result of the acknowledgment that individuals from varying backgrounds with different experiences will have distinct techniques to approach problems, possess unique questioning strategies, and be more likely to cultivate more inventive solutions. Such inclusivity can promote scientific success, economic growth, and global competitiveness (Hong & Page, 2004).

The U.S. Bureau of Labor Statistics projects an 8% increase in STEM jobs by 2029, compared to other non-STEM occupations, with an expected growth rate of 3.7% (Zilberman & Ice, 2021). However, there is a disparate number of college graduates expected in STEM fields, and many of those jobs will remain unfilled (Prescod et al., 2018; Terzi & Kirilmaskaya, 2020). The Committee on STEM Education National Science and Technology Council (2018) reported that 10% of bachelor’s degree conferred annually are in STEM fields. There is not a significant gender difference in the number of degrees awarded by race and ethnicity, except for Blacks; 62% of bachelor’s degrees and 68% of master’s degrees are women, compared to just 38% and 32%, respectively, for men (Fry et al., 2021). Women make up half of individuals employed in STEM occupations, but are underrepresented in engineering (22%), and computer (19%) and physical science (40%) jobs (Fry et al., 2021). Colleges and universities have increased the number of STEM degrees at the bachelor's and master's levels, however there is little evidence that the increase in conferred degrees will significantly shift diversity in terms of gender, race, and ethnicity (Fry et al., 2021).

Statement of the Problem

Overall, efforts to close equity and diversity gaps among the STEM workforce has failed. The Pew Research Center reports that 67% of all STEM occupations are held by Whites, with only 13% Asian, 9% Black, 8% Hispanic, and 3% Native Hawaiian, Pacific Islander, or Alaskan (Fry et al., 2021). STEM workers typically earn higher wages than non-STEM workers, however an equity gap does exist for pay in terms of gender, race, and ethnicity among STEM employees. Asian and White men are among the highest paid STEM employees, while Black and Hispanic women earn less than any other group. The Bureau of Labor Statistics shows that Black, Hispanic, and American Indian or Alaskan individuals have the lowest mean annual income among the STEM workforce (Noel, 2018).

Socioeconomic status (SES) is frequently used in educational research and there have been a multitude of studies conducted on the correlation of SES to educational processes, such as academic achievement (Sirin, 2005). Diversity can also encompass socioeconomic status (SES) and first-generation status, those who are first in their family to attend college. Individuals belonging to low-income households are less likely than their peers from higher economic quartiles to earn a postsecondary degree (Irwin et al., 2021). Black and Hispanic students are more likely to reside in poor, rural areas, and attend high poverty schools than Asian and White students (American Psychological Association, 2017; Gaughan & Bozeman, 2015). Underrepresented minority (URM) students in high poverty areas are dually disadvantaged, in that not only are the majority from low SES backgrounds, but there are also many cultural barriers that exist. Many students who live in poor households encounter traditions that do not embody the importance of postsecondary education, often lack role models in education, and lack the financial resources needed to have access to higher education (Gaughan & Bozeman, 2015). As the income gap continues to grow among American households, the percentage of citizens in the lower income quartile will also increase. Thus, a greater number of resources and investments will be required to increase STEM diversity (Gaughan & Bozeman, 2015).

The National Center for Education Statistics reports that SES has an impact on the educational paths of young adults; 79% in the highest SES tier enroll in college within one year of high school graduation, while only 32% in the lowest tier enroll (McFarland et al., 2019). Additionally, students in the lowest SES quartiles are much more likely to lack persistence in STEM and leave college prior to earning a degree (Chen, 2013); 16% of students from more affluent schools complete a STEM degree within six years, compared to only 8% for students from low-income schools (National Student Clearinghouse Research Center, 2019).

The Program for International Student Assessment (PISA) is a global reading, mathematics, and science assessment of 15-year-olds that is administered every three years; the last assessment was in 2018 and the results were published in 2020. The PISA results indicate that the United States was ranked 24th out of 36 countries belonging to the Organization for Economic Cooperation and Development in mathematics, and 11th in science literacy. In mathematics literacy, males scored higher than females. White and Asian students outscored Hispanic and Black students, and students from low socioeconomic status in the bottom quarter (students eligible for free and reduced-price lunch, FRPL) scored an average of 98 points lower than their peers in the top quarter (Institute of Education Sciences National Center for Education Statistics, 2018). White and Asian students outperformed Hispanic and Black students in science literacy, and students in the lower SES quarter scored an average of 92 points lower than their peers in the highest quarter (Institute of Education Sciences National Center for Education Statistics, 2018). There was no statistical difference in science literacy among males and females.

Disparities among gender, race, and ethnicity can also be seen in the unemployment rates for the second quarter of 2021. The total unemployment rate for all men aged 16 years and older is 6.0%. The unemployment rate for men by race and ethnicity is 5.2% White, 10% Black, 5.7% Asian, and 6.7% Hispanic. For women, the total unemployment rate for the same time period is 5.6%. The unemployment rate for women by race and ethnicity is 4.9% White, 8.5% Black, 5.6% Asian, and 7.8% Hispanic (U.S. Bureau of Labor Statistics, 2021).

The lack of qualified professionals is multifactorial. Community-level factors that ultimately contribute to the weakened STEM pipeline are a lack of consistent STEM strategies adopted by state education departments for K-12 schools, inadequate funding for K-12 STEM education, and lack of educational resources for schools with high percentages of students who are eligible for FRPL. Tsui (2007) states that institutional policies and practices of postsecondary educational institutions is accountable for the low participation rates of some student groups in STEM fields. Faculty perceptions, social pressure, and unwelcoming learning environments also play a role in the disparity of diverse student representation in STEM majors. A student’s encounters will influence sense of belonging. Schools that implement STEM-focused curriculums provide students with greater opportunities to participate and develop interest in STEM (Lynch et al., 2017), but institutions must provide inclusive learning environments for all student groups in order for these experiences to be meaningful (Lynch et al., 2017). Educators and administrators must be willing to address low participation, representation, and engagement of women, underrepresented minority (URM), and underserved (students with low SES) in order to increase the diversity of STEM undergraduate majors.

Purpose of Study

The purpose of this study is to investigate the relationship between the development of a STEM identity, students' decision to pursue a STEM-related field, and their persistence to complete academic requirements to socioeconomic status. The current poverty rate of the United States (U.S.) is 10.5%, and 16% of those in poverty are below the age of 18 (U.S. Census Bureau, 2021). Further, 38.2% of the total population are from minority backgrounds (Black, Hispanic, Pacific Islander, and Alaskan and Native American), but have higher mean poverty rates than the national average at 19.5% for Blacks and 17% for Hispanics (U.S. Census Bureau, 2021). While as many Blacks and Latinos declare STEM majors as Whites, there is a disparity among race and ethnicity in degree completion; 58% of Whites go on to complete a STEM degree, however, only 34% of Blacks and 43% of Latinos persist to degree completion (Riegle-Crumb et al., 2019). Thus, since minorities experience a higher poverty rate and lower STEM graduation rates, it is congruous to study the socioeconomic impacts on factors affecting STEM identity, choice, and persistence among minority groups in comparison to Whites. Socioeconomic status is often a controlled variable in studies on the constructs of STEM choice, identity, and persistence in students, rather than as a variable that has a direct effect. The goal of the researcher is to study SES as a direct effect using recommendations of best practices in measuring social class in research (Diemer et al., 2012).

Theoretical Framework

For this research, a mixed-methods study was conducted using data at a community college and a regional university in the same geographic region, each serving students within a high-poverty area of Tennessee. This study is grounded in the identity theory concept (Burke &

Stets, 2009) as well as Carlone and Johnson's (2007) science identity model using competence, performance, and recognition in STEM. Methodology for determining social status (i.e. SES) will be Pell eligibility and a food security survey adapted from the United States Department of Agriculture (USDA) that will be administered to students enrolled in a community college and university, in line with recommendations on social status measurement in research by Diemer et al. (2012).

Every person is influenced by the people and social groups they encounter. Yucco (2014) states that a person uses other members of society as a reference point for their behaviors and attitudes, and that researchers and educators could profit from a better understanding of how to assimilate the influence of social constructs in their work. The concept of identity theory embodies resources as a component of social structure; actual resources are those factors that operate to reinforce persons or groups, and potential resources are those that may be of future value (Stets & Burke, 2014). Identity is tied to social structure in that the transactive nature of identity upholds the flow of resources, which consequently cultivates societal constituents (individuals, organizations, and groups). Demographic factors such as gender, race, ethnicity, class, and SES are social confines that affect the possibility of an individual entering into specific networks and social circles, as well as being afforded access to resources. In other words, demographic factors contribute to an individual's social identity through which one can identify with others (Stets & Burke, 2014).

The situations in which experiences take place also impact the development of self and identity. As individuals encounter new situations, past experiences may influence the identity development process in that situation. In particular, encounters that elicit positive feelings tend to have a more persistent beneficial effect, while those that elicit negative feelings have less enduring adverse effects (Burke & Stets, 2009). Identity theory has been used to investigate the underrepresentation of women in STEM. Research indicated that science students were most associated with masculine gender stereotypes. Thus, when a female entered a STEM field, they took on meanings that were contrary to their gender (Stets & Burke, 2014). However, females who participate in STEM activities (i.e., STEM summer programs) and actively forge relationships with others in the scientific community develop a stronger science identity (Lee, 2005).

Carlone and Johnson's (2007) science identity model is based upon the tenet of underscoring identity as an analytic lens. A STEM identity lens imbues a novel way of scrutinizing the teaching and learning environment, and allows researchers to probe factors that affect the types of individuals that are promoted and disparaged in the fields, as well as how students come to value (or devalue) STEM, and the ways in which a student's evolving STEM identity may change future plans for persistence (Carlone & Johnson, 2007; Cobb, 2004). A second precept for using identity as an analytic lens is that it implicates the importance of connecting the learning process to the socialization of students into standards and the communication processes in STEM (Brown, 2004; Kelly, 2007). Boaler (2002) states that students who participate in mathematics activities cultivate stronger identities in math. Further, Carlone and Johnson (2007) posit that if science (and STEM, collectively) is thought of as a "community of practice into which aspiring members must be enculturated, it is essential that we understand how neophytes affiliate with, become alienated from, and/or negotiate the cultural norms within these communities" (p. 1189).

Lastly, Carlone and Johnson's (2007) identity model facilitates the endeavor to achieve more equitable STEM education. Science (and all of STEM) education must move away from teaching methodology that portrays science as a construct of knowledge that is finite, as this does not promote the development of strong identities to a diverse group of students. Hence, a greater understanding of the factors that influence the development of STEM identities is pertinent to understanding student choice and long-term persistence in STEM fields.

Research Questions

The research questions and hypotheses were:

1. What is the relationship between STEM identity and socioeconomic factors?

   H1. Students from low SES will have less developed (weaker) STEM identities.

2. Do students of low socioeconomic status have different experiences in STEM?

   H2. Students from low SES will have fewer positive experiences in STEM.

3. How does socioeconomic status impact persistence for STEM majors in postsecondary education?

   H3. Socioeconomic status has a direct impact on students' plans for persistence in postsecondary education.

The intent of the study is to measure socioeconomic as a direct effect on the development of STEM identity, choice, and persistence, rather than just as a controlled factor.

Significance of Study

The data collected from this study could be impactful for educators at all levels of education in determining proactive (and not reactive) strategies for developing more robust interventions for students that may be at risk due to socioeconomic factors, especially in areas with a large number of students who qualify for FRPL in K-12 schools, and for postsecondary adult students who may experience food insecurity. The data could also be useful for college administrators and faculty to understand the challenges that students encounter, be beneficial in assisting public schools program development and targeted interventions for students, as well as more impactful programs to help students transition throughout their educational careers.

Definitions

Identity is a compendium of meanings that construes individuals in the social, emotional, psychological, economic, and physical roles they occupy (Burke & Stets, 2009).

Competence is the ability of someone to carry out and complete tasks (Carlone & Johnson, 2007).

Performance is defined as a person who carries out and completes tasks (Carlone & Johnson, 2007).

P-20 is the collective embodiment of all levels of education and community stakeholders (Murray State University, 2022).

Recognition is referred to as the acknowledgement by self and others that a person is capable of being successful at something (i.e., in STEM) (Carlone & Johnson, 2007).

Self-efficacy is the perception that a person sees themselves as being good at something (Bandura, 1986).

Socioeconomic status (SES) is a measurement of individual or family education, income and occupation (Diemer et al., 2012).

STEM choice is the plan to pursue STEM, or to declare a postsecondary major in STEM (Crisp et al., 2009).

STEM identity is the self-perception of being a scientist, technology expert, engineer, or mathematician (Barton et al., 2013).

STEM persistence is the completion of a postsecondary degree or certificate in science, technology, engineering, and mathematics (Graham et al., 2013).

Underrepresented minority (URM) refers to racial and ethnic groups (i.e., Black, Hispanic/Latino, Pacific Islander, Alaskan or Native American), women, and persons from low SES (Fry et al., 2021).

Summary

The lack of qualified professionals to supply the demand for jobs in the STEM pipeline has been unremitting in recent years, and the gap is projected to continue to grow. The dearth of skilled STEM laborers can be attributed to a plethora of factors. However, ascertaining an understanding of the socioeconomic impact on students' development of a STEM identity and how this can complicate decisions to choose and persist in STEM may be lucrative in identifying proactive strategies to strengthen STEM education by means of igniting stronger interest and participation in STEM. The impacts of socioeconomic status on the constructs of STEM choice, identity, and persistence have not been adequately studied as an isolated variable with direct effect. Chapter two of this study will investigate the literature surrounding what is known about the factors that have been identified as pertinent to the development of a STEM identity. The literature review will also include the contribution of authors whose research has been insightful in garnering a deeper understanding of the variables that are important in students' decisions to pursue a STEM-related major and persist to degree completion.

Chapter II: Literature Review

This chapter describes STEM identity, how it is formed, and factors affecting its development. This development will be explored from a psychosocial lens and on the basis of the fundamental understanding of self and identity. A review of the literature addressing how STEM identity affects STEM choice and persistence is presented. In this review, current research will summarize how student demographic factors and social constructs are related to educational experiences, student interest, and parental education and employment in STEM choice and plans of persistence. This chapter also reviews the shortfalls of previous studies using SES as a predictor for STEM identity, choice, and persistence, and the importance of developing and implementing a more reliable tool to measure the effects of SES on identity, choice, and persistence in STEM. An in-depth examination of the role of SES on the development of STEM identity, choice, and persistence could yield greater insight on barriers and biases that students may experience as they advance in their educational careers, thus strengthening educators' toolboxes on how to effectively implement long-lasting interventions to help students overcome obstacles in growing up to the scientist, mathematician, engineer, and computer programmer they have dreamed of becoming.

STEM Identity

Identity theory states that an individual's self emanates from the mind, is the determinant of identity, and is salient (Burke & Stets, 2009). An individual is cognizant of their self as the motivator of identity. Self is the perception of one's capabilities, beliefs, and mental state, and one's ability to connect with others (Chickering & Reisser, 1993). A person has one self but many identities (Burke & Stets, 2014; Jackson & Hogg, 2010). Identity affords intrinsic motivation and vitality to fulfill the societal roles with which individual identifies (McCall &

Simmons, 1978). Identity is unique to every individual. No two people will interpret the same experiences with the same emotions, values, and beliefs (Schetema & Orgill, 2019). Identity theory posits that gender, SES, ethnicity (social and cultural constructs), and race (biological distinction) play a key part in the development of identity (Archer et al., 2012). It is imperative that a researcher can disseminate the singular effects of each construct in the development of self.

STEM identity is the development of a self-perception that one can see themselves as a professional in a STEM field (Barton et al., 2013). It is fluid and can be shaped through training, relationships, interactions, and practice. Practice requires education, ability, and participation (Barton et al., 2013). However, it can be non-discernible for some adolescents due to prevalent ideologies in regards to race, gender, and social status (Archer et al., 2010). The development of an identity in STEM can emanate from limitations and assets in geographic regions (Carlone & Johnson, 2007) and be augmented from positive peer relationships that predicate one's perception of belonging (Estrada et al., 2011; Saha et al., 2013).

Purdie-Vaughns et al. (2008) state that climate (and culture) of educational space affects identity. The climate of any educational institution determines if an environment is conducive to learning and is interdependent with its culture, which is built from shared values and beliefs (Allen-Ramdial & Campbell, 2014). The U.S. Census Bureau (2021) states that 12.3% of Americans (34 million people) live in poverty; 16.8% are under the age of 18. Fewer Whites and Asian-Americans are in the low socioeconomic bracket, both with 7.3%, however, 18.8% of Blacks and 15.7% of Hispanics live in poverty (U.S. Census Bureau, 2021). Schools with a high percentage of students receiving free and reduced lunch do not receive the same funding as schools in more affluent areas. This results in schools that cannot offer competitive academic curriculums and technological resources, and generally lack community support (Gaughan & Bozeman, 2015). Underfunded schools typically employ a larger percentage of teachers with fewer years of teaching experience and have high teacher turnover rates. Identity theory states that an individual's identity is linked to social structures and culture (Stets & Burke, 2014), thus students enrolled in underserved schools without appropriate educational resources may not develop strong identities in STEM or non-STEM fields.

Dou et al. (2019) studied the interconnectedness of students' adolescent STEM-related experiences with their STEM identity and future college major aspirations. Results of the study indicated that a strong STEM identity was a significant predictor of students' plans to major in a STEM field in college. Students who had a strong STEM identity were more likely to talk with others about their interest and read or watch science fiction during elementary school. Dou et al. (2019) also noted that student participation in extracurricular science or math activities, camps, or competitions was not predictive of a persistent STEM identity. Clearly, there are multiple factors that can play a pivotal part in the development of a STEM identity. However, the relationship among the variables, and whether one stands out as more influential has not been thoroughly studied.

Timing

Research shows that initial interest in science begins prior to or during middle school (Hill et al., 2011; Maltese & Tai, 2010), and that it becomes progressively more difficult to engage students in STEM as they transition into high school (Barton et al., 2013). Lindahl (2007) found that the career aspirations of females were predominantly formed by age 13. Archer et al. (2010) conducted a study to learn what factors are important to develop a STEM identity among a group of socioeconomically and ethnically diverse 10-year-old students. The data from the study indicated that there was a high interest in science at age 10, most prevalently in the context of tactile activities (Archer et al., 2010). However, there was concern among the students in terms of science being safe or dangerous; real science was misconstrued to be dangerous (i.e., explosions and bangs) and in disagreement with school science. Girls were more likely than boys to be discouraged if they thought science was dangerous, whereas boys were more likely to be intrigued if they perceived a heightened sense of danger (Archer et al., 2010). The study also indicated that while a student can be enthusiastic for science, a student may concurrently perceive oneself as a science person and choose to not study science or other STEM fields in the future (Archer et al., 2010). Although the study sample included students from diverse ethnic and socioeconomic backgrounds, neither of these variables were studied as a direct effect. This study will investigate what role these social constructs play in the development of a STEM identity in middle schoolers, as well as whether SES complicates the experiences that shape the STEM identity of middle schoolers.

Competence, Performance, and Recognition

Carlone and Johnson (2007) studied the experiences of underrepresented minority (URM) females during their postsecondary studies and early careers in science to better understand the development of their science identities. The basic model for science identity included competence, performance, and recognition; a competent person is capable of doing something well, is able to demonstrate (perform) their competence, and is recognized by their peers for their ability (Carlone & Johnson, 2007). The model was based on the presupposition that gender, race (biological distinction), and ethnicity (cultural and social constructs) influence science identity.

Findings of the study indicated that recognition by others play a pivotal role in the development of science identities in URM women. The study further disaggregated the data into the following identity paths: research scientist identity, altruistic scientist identity, and disrupted scientist identity. Women in the research scientist path “saw science as an exciting way of knowing, expressed the importance of science for science’s sake, and conveyed an interest in studying the natural world,” (Carlone & Johnson, 2007, p. 1197). For those that identified as research scientists, all said that their self-perceptions as a scientist were primarily due to recognition by peers for their work. The women that were classified as altruistic scientists “created their own definition of science, redefined whose recognition mattered to them, and, in some cases, redefined what it meant to be a woman of color in science,” (Carlone & Johnson, 2007, p. 1199). These women perceived themselves as doing science to serve people; the absence of recognition did not preclude their sense of being a scientist. Those in the group of disrupted scientists tended to fixate on negative experiences in their science education and careers. Their self-perceptions as scientists initially aligned with the research scientist and altruistic scientist groups, however, over time, they began to feel disaffected and unnoticed during their education and careers (Carlone & Johnson, 2007).

García et al. (2019) investigated the assumption that a STEM identity using Carlone and Johnson’s model for science identity development can be applied to not only URM women, but to Black students as they transition from a 2-year to a 4-year institution, specifically students’ STEM paths. The study investigated if competence, performance, and recognition were related to Black students’ decision to major in a STEM-related discipline and if any of these factors are specific to Black students’ transfer from a 2- to a 4-year postsecondary institution. Results indicated that competence and performance were important aspects of STEM identity in their choice of a STEM major and transference to a 4-year institution (Garcia et al., 2019).

Barton et al. (2013) states that identity is developed through practice. Thus, one develops a STEM identity through mastering concepts that envelope the social and cultural practices of STEM. Positive relationships and recognition with the STEM community serve to augment self within the construct of science identity. Barton et al. (2013) studied the science identities of two female Black middle school students. One student attended school in a large, urban school with unemployment rates higher than the national average. The student was labeled high-ability, demonstrated excitement for science, and initially participated in science club. During seventh grade, the student stopped going to science club due to social pressure, and received less recognition for her efforts in science class. By the eighth grade, the student began to struggle in science and transitioned from an active participant to an observer in class, and eventually began to think of herself as "not a science person."

The second student attended school at an urban magnet school for the arts. She was labeled mid-level in terms of ability, and earned lower grades in science and math compared to history and English. The student participated in science activities at a youth center, where she was eager to share thoughts and ideas, however in science class, she was shy and reserved. The student did not initially identify as a science person, and was more interested in dance and art. Over time, she was able to incorporate her dance and art into making a film for science class. She received positive recognition from her science teacher and peers, which shifted her perceptions of self to that of a science person (Barton et al., 2013).

The works of Barton et al. (2013), Carlone and Johnson (2007), and Garcia et al. (2019) clearly emphasize the importance of competence, performance, and recognition in the development of a science identity. Further, Barton et al. (2013) indirectly implied the effect of SES on science identity development, with the case study of the middle school student from an urban school situated within a community with high unemployment rates. The goal of this study to further investigate the direct role of SES on the development of STEM identity among postsecondary students in a community college and regional university in a rural region of northwest Tennessee with poverty rates above the state average.

Self-Perception

Self-perception is a person's view of themselves and is comprised of the mental and physical qualities of self (Stets & Burke, 2014). Self-perception is not static, and can be shaped by positive experiences, thus, it is an essential element in the construction of STEM identity for students in all levels of education. Hazari et al. (2010) investigated the impact of students' secondary school experiences and future career goals on their science (physics) identity, which was composed of academic performance, competence, recognition, and interest. Data for the study was obtained from the Persistence Research in Science and Engineering (PriSE) study, which was a broad, national survey of postsecondary students enrolled in introductory English courses in 2007. Results of the study indicated that students' self-perception as a physics person was predictive of plans to pursue physics as a college major. Physics identity was predicated by participation in tactile physics activities in high school that emphasized the positive impact of science, real world connections, and engagement of students in discussion (Hazari et al., 2010). Significantly more males than females exhibited a physics identity, however targeted discussion on female underrepresentation in physics was a positive predictor on physics identity for females (but not males). Kane (2016) reported on the impact of academic and science experiences of two Black males on the development of their science identities. Each student perceived themselves as competent in science and discussed the importance of being recognized as good in science by their teacher (again seeing competence and recognition in a manner aligned with that of Carlone and Johnson, 2007).

Godec (2018) probed the science identities of five girls aged 11-12, from various ethnicities and low socioeconomic status. Qualitative data suggest that the development of science identities for the students in the study was a result of the following factors: the mindset that anyone can do science (not gender exclusive), learning about female scientists in school, students' perceptions that science can be for the good of humanity (in contrast to the notion that science is a field devoid of emotion), and cultural influence (parental or familial expectations).

Kang et al. (2018) investigated factors that influence Black middle school girls' science identities from schools in impoverished communities in four states. The study found that there were no racial or ethnic differences in the development of STEM identity among middle school girls. Self-perception was the strongest indicator of STEM identity among girls; self-perception was formed from good science experiences inside and outside the classroom and at home. Allen-Ramdial and Campbell (2014) make a pertinent point in the discussion on STEM identity, choice, and persistence among women and URM; not all belong to the same SES group and not all racial groups share the same ethnic identity, thus all women and URM should not be analyzed under the same lens.

Self-perception is a strong predictor on STEM identity (Godec, 2018; Hazari et al., 2010; Kane, 2016; Kang et al., 2018). Being recognized as "good at science" was shown to be an important factor in the development of self-perception (Kane, 2016), thus reiterating the ideology of the predictive power of recognition on performance and competence (Carlone & Johnson, 2007). Godec (2018) further shed light on the development of self-perception among URM female students in middle school, presenting evidence that mindset and culture are important factors. Yet another study posited that self-perception among girls was independent of race and ethnicity (Kang et al., 2018). Although self-perception is a strong predictor of STEM identity, its development is not congruous across students. Therefore, it is pertinent to consider the common denominators among student groups when examining STEM identity, and to be mindful of how to measure their effects.

Extrinsic Factors

Ortiz et al. (2019) explored the development of science identities among 14 Black postsecondary STEM students that were participants of undergraduate research programs at their educational institution. Survey analysis revealed the importance of family impact (i.e., a family member in a STEM-related job), the existence of emotional and academic resources in higher education, positive experiences in STEM courses, cultural inclusiveness, positive communications, and intrinsic motivation to complete STEM-related goals on science identity development.

The survey participants discussed the importance of familial support when enrolled in difficult STEM classes, and expressed the roles of that family members played in offering encouragement, as well as modeling what an underrepresented minority looked like in a STEM career (Ortiz et al., 2019). The STEM students also cited the positive impact of teachers, friends, and fellow classmates on boosting the morale and persistence while enrolled in postsecondary STEM classes. Results indicated that these students were able to navigate educational spaces that were initially uninviting, including seeking out help from professors and taking advantage of academic resources to improve their success (Ortiz et al., 2019). Another aspect each of the STEM students surveyed was that they each expressed intrinsic motivation to succeed in STEM.

Steinke (2017) suggests that the media can play a role in the development of a STEM identity, especially among URM and female students. Historically, STEM professionals have been predominantly White, middle-class males, and have been portrayed in textbooks, films, and other media images (Miller et al., 2018). The portrayal of a broader diversity of STEM professionals featuring women and URM groups may play an important role in changing attitudes and sparking interest toward science, especially among adolescent girls (Steinke, 2007). Further, media should also consider the psychological effects of their portrayals of STEM professionals and how a STEM identity can be integrated with other social identities (Carlone & Johnson, 2007). Brickhouse et al. (2001) presented research suggesting that the social identities of STEM professionals depicted in the media can positively impact STEM identity formation.

Interest

Maltese et al. (2014) studied factors that generated long-term interest, and persistence in, STEM pathways using the framework that interest development is either situational or individual (Renninger & Su, 2012). Situational interest is developed as an individual is exposed to learning events that evoke extrinsic motivation to learn more about topics. Individual interest is intrinsically developed and is believed to be more impactful in long-term interest (Renninger & Su, 2012). Individual interest is developed in a four-stage process:

Stage 1. An event occurs to incite interest.

Stage 2. An individual is extrinsically motivated to learn more about a topic.

Stage 3. An individual becomes motivated to learn more about a topic on their own.

Stage 4. An individual becomes intrinsically motivated to develop their sense of understanding about a topic.

As an individual develops individual interest and continues to invest more time into learning about a topic, it solidifies one's expectations for being successful in a topic and thus, is predictive of persistence in that topic (Wigfield & Eccles, 1992). The findings suggest that there are not consistent factors that can be applied across all STEM completers. Individual interest is an intrinsic motivator that can influence STEM identity and plans of persistence; however, it is a psychological attribute that is not consistently evoked across students (Harackiewicz et al., 2018).

The development of a STEM identity is an ongoing evolutionary process that is affected by a plethora of variables. The educational climate and culture can foster an interest in science, technology, engineering, and mathematics, and educators can have positive influences on students' perceptions of their ability to do well in those areas, but there is so much more at play. Research supports the idea that timing is pertinent in inciting ongoing excitement, interest, and participation. As student participation increases, competence is boosted. Competence bolsters student performance. Exemplary performance earns recognition. Recognition feeds perceptions of self-efficacy. But it does not stop there. Other considerations are the positive effects of familial support and a broader and more diverse representation of STEM professionals on the adaptive qualities of STEM identity.

STEM Choice

Student choice in STEM is defined in the context of choosing a major in a STEM-related field while enrolled in a postsecondary institution. Although there has been a multitude of strategies employed across all sectors of education, males are predominant in STEM fields in comparison to females (Crisp et al., 2009; Evans et al., 2020; Estrada et al., 2011; Kaleva et al., 2020), and minority groups are persistently underrepresented (Crisp et al., 2009; Niu, 2007).

There are many theories that are used to explain factors affecting STEM choice. The Social Cognitive Career Theory (SCCT) is based on the social cognitive concept introduced by Bandura (1986) and was proposed by Lent et al. (2000). According to the SCCT, personal experiences, environment, and behavior influence an individual's career plans and choice (Maltese & Tai, 2011). Academic experiences (inside and outside the classroom), social constructs, self-efficacy, and demographic constructs are some of the factors that can determine environment, affect behavior, and shape personal experiences (Archer et al., 2010; Bandura, 1986; Heilbronner, 2011; Wang, 2013).

Academic Experiences

Heilbronner (2011) investigated students' ability, interest, self-efficacy, and academic experiences on STEM choice and persistence among Science Talent Search semifinalists and finalists from 1987 to 1989 and 1997 to 1999. While many high-ability students who declared STEM majors completed a STEM degree, approximately 25% changed their major to non-STEM. Results of the study indicate that student self-perceptions and academic experiences in introductory college STEM courses were predictors of STEM choice in college (Heilbronner, 2011). College-level general chemistry is often a gatekeeper course, and a study of 1,690 students by Cohen and Kelly (2019) revealed that 49% changed their degree plan to a non-STEM major after taking the course.

Lee (2013) analyzed data from the Educational Longitudinal Study of 2002/06 and found that computer-based learning activities in K-12 math classes were positively correlated with STEM choice in college over other pedagogical activities; individual activities and extrinsic motivation from teachers (in secondary school) increased academic performance in math. The results of this study imply that students' interests in STEM could be augmented by assimilating

STEM contexts into traditional teaching and learning opportunities in K-12 mathematics courses. Teacher enthusiasm and motivation can also be an important factor, as teachers construct and carry out lessons (Lee, 2013).

Gender Stereotypes

Females from all racial and ethnic groups across SES backgrounds also have lower STEM interest, participation, and persistence (Saw et al., 2018). Riegle-Crumb and Peng (2021) examined data from the High School Longitudinal Study (HSLS:09) in terms of gendered belief as predictors about math efficacy, and found that Black females more frequently perceived females were better at math, however, stereotype perception of female superiority does not persist as SES increases; as SES increases, perceptions of male superiority become more frequent. Male students with lower academic performance were more likely to perceive that females were better in math, and vice versa for males who were higher academic achievers (Riegle-Crumb & Peng, 2021). However, there was no correlation between STEM choice and females who affirmed male superiority; females who perceived males as being superior did not choose STEM less frequently.

Miller et al. (2018) conducted a meta-analysis of 50 years of Draw-A-Scientist studies in the United States and found that there is still a strong prevalence of gender stereotypes in science. The findings show that adolescents associated males as scientists at a higher frequency that females, despite efforts to increase female representation in science.

Self-Efficacy

Self-efficacy is an individual's perception of their ability to complete tasks and is associated with past experiences, emotions, and recognition by others (Bandura, 1986). The capability to accomplish tasks is dependent upon one's perception (self-efficacy). Individuals with high self-efficacy are more likely to exhibit persistence in the face of challenges, whereas someone with low self-efficacy will steer away from challenges (Bandura, 1986). Math self-efficacy is one's belief that they are good at math, and is a predictor of STEM persistence (Sax et al., 2015).

Bleeker and Jacobs (2014) examined the effect of a mothers' early beliefs of their child's abilities and the child's self-perception of their math and science abilities. Results showed that children with higher self-efficacy of math and science had mothers who also perceived their children as having high ability in math and science during and after high school (Bleeker and Jacobs, 2014). Thus, mothers' perceptions of ability of their children have long-term significance on their child's self-efficacy (Bleeker & Jacobs, 2014).

Crisp et al. (2009) examined the determinants of STEM choice for postsecondary students at a Hispanic Serving Institution (HSI) and found that gender, ethnicity, math performance on the SAT, high school GPA, and enrollment in introductory math and science courses were significant predictors of STEM major choice. An institution that is classified as an HSI has a minimum full-time enrollment of 25% Hispanic, of which half are low SES (Bordes & Arrendondo, 2005). Amongst students who completed STEM degrees at the HSI, a greater number of Hispanic students were Pell eligible and first-generation college students compared to Whites (Crisp et al., 2009). STEM persistence data indicated that males were more likely than females to declare STEM majors, Asian Americans were nearly two and a half times more likely to earn a STEM degree when compared to Whites, and higher math SAT scores and high school GPA were significant predictors. First semester postsecondary enrollment in Algebra I or higher yielded a 2.27 times lower probability of completing a STEM degree, and first semester enrollment in Biology I or higher were 5.74 times lower (Crisp et al., 2009).

Evans et al. (2020) investigated STEM choice in community colleges with data from the 2002 Education Longitudinal Study. The results of the study indicated that self-efficacy in secondary math and introductory lab science and advanced math courses in college were indicators of STEM choice in community colleges. Females were less likely than males to declare STEM majors (Evans et al., 2020). Moreover, females who initially have high math self-efficacy and choose postsecondary STEM majors tend to show a decline in their perceived math ability due to factors such as experiences with faculty and competitiveness among peers (Sax et al., 2015).

Moakler and Kim (2013) analyzed data from the National Freshman Survey and found students' self-efficacy in math was a strong predictor in STEM choice. Students were also more likely to choose STEM in college if they had a parent with a STEM occupation. There were gender differences in STEM choice (more males than females), but race and ethnicity were not predictors of choice. As many Black and Hispanic students were likely to choose STEM majors as White and Asian American students (Moakler & Kim, 2013).

Rinn et al. (2013) investigated SES, maternal and paternal education level, and perceived family social support as indicators of math self-efficacy and found that females have lower math self-concepts than males, and that math self-efficacy was directly impacted by familial support for both genders, but the correlation was much stronger for males. Asian and White students had higher self-efficacy in math than Black and Hispanic students. There was a positive (but not significant) correlation between maternal education level and math self-efficacy among females, but not males. Paternal education levels did not predict math self-efficacy for males or females (Rinn et al., 2013).

STEM choice is a direct effect of self-efficacy perception (van Aalderen-Smeets et al., 2019). Some individuals have a fixed mindset, in which they believe that their intelligence and abilities cannot be changed; an individual's mindset can shape their perceptions and beliefs about their abilities (Dweck, 2006). van Aalderen-Smeets & Walma van der Molen (2018) presuppose three pathways to understand the malleability of STEM identity and choice, and thus provide relevant interventions aimed at developing them: self-efficacy perceptions, stereotype threats, and intrinsic motivational beliefs. Wang (2013) postulates that a deeper understanding of the factors affecting STEM choice is necessary for developing educative policies and interventions steered toward promoting perceptions and attitudes that promote STEM choice and identity among especially URM students.

Socioeconomic Status

Niu (2017) utilized the Education Longitudinal Study of 2002 to investigate the effect of SES on STEM choice. Data analysis indicated that females chose STEM less frequently than males, more Asian students majored in STEM than in non-STEM, and there are more Whites and Hispanics majoring in non-STEM than STEM. Scores on math SAT were predictors of STEM choice, family SES was not, but the percentage of high school SES was, meaning that STEM choice is higher for students coming from low SES high schools (Niu, 2007). Results also indicate that there is a stronger positive correlation between SAT scores in math and STEM choice when family SES increases. Higher SES was predictive of STEM choice for a greater percentage of Black students and females (Niu, 2007). It is pertinent to emphasize that the results of Niu's study are in contrast to the vast underrepresentation of URM in STEM, as Black students have a higher probability of choosing STEM majors over White students when other demographic factors are controlled. Black students from low SES do not illustrate the same trend in STEM choice (Niu, 2007). However, a study conducted by Saw et al. (2018) did reveal that low SES Black and Hispanic males frequently had decreased interest and persistence in STEM compared with White males from higher SES.

Cooper and Berry (2020) state that low SES is a strong predictor of STEM choice among high school students, but that ethnicity and gender can also play a role. Further, a student can belong to low SES, be an underrepresented minority, and female, confounding results. Females are less likely to choose STEM in postsecondary education, as are students who belong to URM groups (Cooper & Berry, 2020). Schools in less affluent neighborhoods lack funding to provide competitive educational resources to support student interest and increase participation, producing negative effects on student growth and achievement (Aikens & Barbarin, 2008). Morgan et al. (2009) presented research supporting the understanding that students from low SES families often experience a delay in attaining academic skills in comparison to their peers from higher SES families.

It is well understood that academic experiences can steer a student towards (or away from) plans to pursue a subject. STEM is largely dominated by White, middle-class males, despite the fact that as many females and URM plan to major in STEM as their White, male peers. Another goal of this study is to investigate whether SES further complicates the biases implicated by cultural traditions and gender stereotypes, and how this may account for the gender and diversity gap among students.

STEM Persistence

Students' STEM identity is most strongly developed during middle school, where educational and extracurricular activities and good role models positively influence a student's perception that they can see themselves as a successful scientist. Students who develop strong

STEM identities will often choose to major in STEM upon enrollment in a postsecondary institution (Wang, 2013). Persistence is defined for the purposes of this study as those who complete a STEM degree.

Graham et al. (2013) suggests that efforts to increase STEM persistence should focus on motivation and self-confidence of students. Programs that have garnered success in STEM persistence have increased motivation and self-efficacy by offering early research opportunities, are rich in active-learning pedagogies, and provide STEM learning communities (Graham et al., 2013). Such programs have broad buy-in from faculty, provosts, deans, chairs, and community stakeholders.

The Joint Working Group on Improving URM Persistence in STEM was tasked by the National Institute of General Medical Sciences and Howard Hughes Medical Institute to audit promulgated literature on barriers to STEM persistence in URM and propose consideration as to why STEM pathways have fewer URM students persist compared to White and Asian students (Estrada et al., 2016). One recommendation from the committee is for postsecondary educational institutions to track and publish the ethnic identities, gender, and SES of students who begin, withdraw, or complete degree programs, as well as the time to degree completion, current institutional intervention programs for URM, and research participation of URM and non-URM students (Estrada et al., 2016). Tracking and publishing this data is not a requirement in higher education, however, such data could be most beneficial for researchers studying factors that affect STEM persistence. Another recommendation of the committee was to create partnerships with institutions that have successful programs, adapting them to fit the specific needs of their institution. Students in low SES are more likely to work while attending college, hence they become less likely to participate in research or extra-curricular STEM activities. The committee recommends that low-income students be supported with more federal and private funds to break down this barrier (Estrada et al., 2016).

Institutional Climate and Culture

Allen-Ramdial and Campbell (2014) state that significant challenges to STEM persistence occur at the transition from undergraduate to graduate studies, where there is a stark misalignment of institutional climate and culture, which negatively impacts students' sense of belonging, without regard to demographic factors such as race, ethnicity, or socioeconomic status (Cohen & Garcia, 2008). Postsecondary faculty can improve climate and culture by forging partnerships with students, thus increasing their sense of belonging and positively impacting students' plans of persistence in STEM (Allen-Ramdial & Campbell, 2014). Partnerships between institutions can also dismantle teaching and research silos, pinpoint deficiencies in academic and skills preparedness, and decrease STEM attrition. Interinstitutional partnerships may also be beneficial in cultivating social competency among URM students from low socioeconomic backgrounds with low social status, and can be constructive in helping faculty identify when these demographic factors negatively affect students' academic performance (Allen-Ramdial & Campbell, 2014).

Pedagogy

Almarode et al. (2018) examined the association of secondary student experiences with pedagogical strategies of surface versus deep learning in STEM course and STEM graduates' perceptions of college readiness and plans for college completion with a STEM degree. Surface learning can be defined as covering a broad spectrum of concepts not covered in great detail, and deep learning as in-depth learning of targeted concepts. Controlling for demographic factors, results indicate students attending high schools utilizing deep learning were significantly more likely to report perceptions of being college-ready and an increased probability of STEM major choice in postsecondary education. The number of secondary STEM courses completed was negatively correlated with reported college readiness. Gender, race, and parental education were not significant predictors of being more likely than their peers in reporting experiences with deep learning (Almarode et al., 2018).

Anderson and Ward (2013) explored factors affecting plans of STEM persistence among high-ability ninth grade Black, White, and Hispanic students. High ability was defined as scoring in the top 10% of their race on the achievement test for mathematics. The variables used to identify STEM persisters were students' perceptions about their abilities in mathematics and science (efficacy), students' perceptions about their science identity compared to their perceptions of if others viewed them as such (attainment value), whether students planned to take more science or math courses (utility value), and students' reasoning on why they planned to take additional secondary science or math courses (intrinsic value) (Anderson & Ward, 2013).

Attainment and intrinsic science values, and STEM utility values were predictive of plans to persist in STEM, but there were differences in their effects among different student groups (Anderson & Ward, 2013). Black persisters had significantly higher scores on their mathematics achievement test, science intrinsic value, and science attainment value than non-persisters. Hispanic persisters had higher utility value and science attainment values than non-persisters. White persisters had significant differences on self-efficacy in science, science intrinsic value, and math and science attainment value than non-persisters (Anderson & Ward, 2013).

Stereotype Threat

Beasley and Fischer (2012) studied how stereotype threat affected the persistence of first-year women and URM students in STEM majors. Stereotype threat was defined in this study as anxiety resulting from students' assumption of judgment based on negative group stereotypes (Beasley & Fischer, 2012). Data indicates that freshman URM students experience more stereotype than Whites, but females do not experience more stereotype threat than males. Further, the study indicates that stereotype threat is a significant positive predictor for women, URM, and White male STEM attrition (Beasley & Fischer, 2012).

King (2016) investigated the effects of gender on STEM persistence in postsecondary education. The STEM areas investigated were engineering, mathematics, physical science, computer science, and life science. Persistence was defined as earning a degree in initial declared major. Results did not show a significant gender difference in all intended STEM majors, nor in the specific STEM areas investigated.

Self-Efficacy

Cabell (2020) studied career search self-efficacy as a predictor of persistence in STEM in engineering students and found that among students who had higher self-efficacy scores were more likely to persist as an engineering major. Data was collected using a career search self-efficacy survey from students enrolled in a STEM career planning course in which they were asked to state how likely there were to major in engineering in the subsequent term. Eighty-six percent of respondents indicated a high likelihood (Cabell, 2020). However, it should be noted that 30% of the survey respondents were third- or fourth-year college students, and the greatest percentage of STEM attrition occurs within the first two years of postsecondary education.

Mau (2003) investigated race and gender as indicators of science and engineering persistence using data collected from the National Education Longitudinal Study of 1988 (NELS:88). The NELS:88 surveyed eighth graders, and one parent, two teachers, and school principal for each participant. Results indicated that STEM persistence was most strongly predicted by students' perceptions that they could be successful in math and academic ability. Females were less likely to persist in science and engineering career aspirations than males (Mau, 2003).

Academic Achievement

Cohen and Kelly (2019) examined the relationship between student academic achievement in introductory chemistry courses at a community college and STEM degree persistence. Findings indicate that academic success in chemistry was a significant predictor in students' decisions to change their majors to a non-STEM discipline, and biology and anatomy and physiology course achievement were indicators of STEM persistence (Cohen & Kelly, 2019). However, a pertinent point to disclose is that the community college where the study was conducted did not require students to meet with an advisor prior to registering for classes, several chemistry courses were offered for students with different majors, and courses were not identified in the class schedule as being majors or non-majors, thus, it is possible that students enrolled in a course that was not aligned to their declared major and/or their skills in mathematics (Cohen & Kelly, 2019).

Dika and D'Amico (2016) researched the influence of secondary and early postsecondary experiences on the persistence in a subset of STEM fields (physical science, engineering, math, and computer sciences) among first-generation college students in comparison to other STEM and non-STEM majors. First-semester grade point average (Crisp et al., 2009; Dika & D'Amico, 2016) and perceived math preparation were significant indicators for persistence among the studied subset of STEM students studied (Dika & D'Amico, 2016). However, it should be noted that students' perceptions of math preparation were not a significant predictor in other STEM fields (Dika & D'Amico, 2016).

Dwyer et al.'s (2020) exploration of STEM attrition at the United States Air Force Academy identified factors affiliated with persistence in STEM, students' motive and inclination to major in STEM, and academic achievement in postsecondary academic achievement in specific advanced mathematics. The findings suggest that students are more likely to switch to a non-STEM major if they struggle in these courses.

Data from the NELS:88 was used by Griffith (2010) to investigate variables contributing to STEM persistence in all students, but especially women and URM. The NELS:88 was a long-term study in 1988 that followed students from eighth grade through college, consisting of five student surveys, and high school and postsecondary transcripts through the year 2000. The disparity in the rates of persistence were due to differences in academic preparation and students' educational experiences. The study also revealed that a greater number of female and URM graduate students in STEM positively impacts STEM persistence of female and URM students (Griffith, 2010).

Ikuma et al. (2018) presented a paper describing the effect of the STEM Talent Expansions Program (STEP) at Louisiana State University (LSU) on persistence of first-year STEM majors. Results indicated that program participants had higher rates of persistence than nonparticipants, which the largest percentage of persistence in engineering. When demographics were factored in with the STEP program, higher family assets and math scores on the ACT increased STEM persistence at LSU, but with a small effect size.

Maltese and Tai (2011) analyzed students' academic experiences and achievement in math and science from eighth grade to college graduates with data collected from NELS:88. Surveyed students were asked to respond to inquiries about student interest, experiences in educational activities, the level of difficulty of coursework, and pedagogical strategies they encountered. Students' high school and college transcripts were also analyzed. The data analysis revealed a positive relationship in completing a STEM degree by Asian students, eighth grade math and science performance, students who perceived science as a useful subject for their future, and planning to have a science or math-related job were also more likely to persist in STEM (Maltese & Tai, 2011). Twelfth grade students were significantly more likely to graduate college with a STEM degree than students who planned to major in STEM compared to students who indicated a non-STEM major (Maltese & Tai, 2011). Postsecondary students who experienced poor academic performance or had a child while enrolled were more less likely to persist in STEM. Student demographic factors (race, gender, and SES) were not predictors of STEM persistence.

Turetsky et al. (2020) conducted a study in which students enrolled in a gateway biology course were designated to either a control group or to a group that was instructed to complete a psychological intervention activity for an entire term. At the conclusion of the term, students who completed the affirmation exercise had approximately 29% more friends in the course that students in the control group. Student connections were predictive of STEM persistence, in that the affirmed students were nearly 12% more likely to enroll in the subsequent biology course sequence. Course performance was not affected by the intervention activity (Turetsky et al., 2020).

Extrinsic Factors

Foltz et al. (2014) studied factors that enhanced STEM persistence of URM students. In the study, URM was defined as “African-Americans, Alaskan Natives, American Indians, Hispanic Americans, Native Hawaiians, and Native Pacific Islanders” (National Science Foundation, n.d., ¶ 1), and degree completion was used to measure persistence (Foltz et al., 2014). Results indicate that familial and community support, participation in college preparatory science and math courses, and social and academic integration were important factors in persisting to STEM degree completion (Foltz et al., 2014). However, the study consisted of a small sample size of only eight individuals, all of whom were female except one.

Belser et al. (2016) used three variables to investigate student STEM persistence: STEM-focused career planning intervention, students first declared major, and Career Thoughts Inventory (CTI) score changes. All variables were significant predictors of STEM persistence. Thus, STEM major students who participated in career planning and have fewer negative career thoughts were more likely to stay persist in their major (Belser et al., 2016).

Brookover (2020) examined the relationship between college readiness counseling in high school and demographic factors (first-generation college student, race/ethnicity, gender, and socioeconomic status). Race and ethnicity were not delineated, and were classified as White, Black, Asian, Alaskan, American Indian, Hispanic, and Native Hawaiian or Pacific Islander. Results indicated that there were no significant differences in the amount of time that school counselors spent with students of different genders or race/ethnicities. There were also no differences among college readiness counseling and first-generation college students of different genders and or race/ethnicities (Brookover, 2020).

School counselors spent less time on college readiness counseling with students who were in lower socioeconomic brackets as compared to students in the middle- or higher-income classifications (Brookover, 2020). First-generation college students typically come from families with lower SES (Engle, 2007). Research indicates that first-generation college students from low SES backgrounds are twice as likely to leave college without earning a degree as compared to students from more affluent backgrounds (Cahalan et al., 2019). Brookover (2020) also noted that access to college readiness counseling increased a student's probability of persistence three years past high school graduation.

Attrition from STEM Fields

Jelks and Crain (2020) present data to repute the commonly thought notion that there are not enough STEM graduates, but rather, that many STEM baccalaureate graduates do not intend to remain in the field. The study found that non-Asian underrepresented minority graduates demonstrated a higher likelihood of leaving a STEM-related career, citing that one-quarter of survey respondents expected to persist in STEM past age 30. Further, less than 60% of the same survey cohort were working in a STEM-related field post-graduation (Jelks & Crain, 2020). STEM career persistence was significantly related to college research participation and completing an internship or other STEM placement, while non-persisters cited not securing a job in a STEM field that was an area that augmented their future career aspirations. Reasons for STEM career attrition in URM (non-Asian) were reported to be a perceived lack of employment opportunities in their field, feeling too qualified for a job, being unable to move for a job, or lack of networking connections (Jelks & Crain, 2020).

The inception and evolution of a STEM identity is convoluted with a multitude of interacting factors. Those factors are the major players in a student's plans to pursue and persist to degree completion in STEM fields and to eventually join the pipeline of global professionals. There is no singular consistent variable across all STEM-persisters, and the combinations of adaptive factors are seemingly infinite. However, investigating the underlying effects of SES on these constructs may yield clues as to why some persist and others do not.

STEM Academy

Findley-Van Nostrand and Pollenz (2017) implemented a STEM academy targeting pre-college students that focused on psychosocial factors related to STEM retention: science identity, self-efficacy, sense of belonging to college and STEM, career expectations, and plans to not persist in STEM. Results of the STEM academy indicated that students' science identity and sense of belonging were much higher than a comparison group of first-year students, and posits the possible implications of implementing a STEM academy as a co-curricular push to improve STEM retention, and thus persistence (Findley-Van Nostrand & Pollenz, 2017). The authors suggest such a strategy could be particularly beneficial to increase sense of belonging among women and URM, both groups of whom may be subjected to bias and stereotype threats from majority students (Estrada et al., 2011).

Socioeconomic Status

The United States is comprised of 261 million individuals made up of 57.3% White, 11.9% Black, 19.5% Hispanic or Latino, 6% Asian, and 0.8% Native Hawaiian, Pacific Islander, American Indian, or Alaska natives. The overall poverty rate is 10.5%, with 16% of children under the age of 18 living in poverty (U.S. Census Bureau, 2021), one of the highest poverty rates for children in a first-world country (American Psychological Association Task Force on SES, 2007). As the population continues to increase, the income gap will almost certainly increase as well. Socioeconomic status has been shown to be significant predictors of health, academic achievement, prosperity, and mortality (American Psychological Association Task Force on SES, 2007).

The National Center for Education Statistics (2014) reported that the high school dropout rate of students from low SES was 11.6%, compared to 2.8% for students from higher SES. Douerschuk et al. (2016) stated that the persistence of low SES students in STEM is much lower in comparison to students from families with higher SES. Students from the highest SES are eight times more likely to graduate with a college degree than students from the lowest SES (U.S. Census Bureau, 2014). Despite the importance of SES on education, many studies have not considered its effect amply. It is well understood that schools from less affluent areas have fewer financial resources to afford their students an equitable education compared to schools from more affluent neighborhoods. Families who live in less affluent areas are less likely to have the ability to relocate to access better schools, and thus, schools in lower SES underserve their students in terms of academic, emotional, and social support structures.

Socioeconomic status is profoundly associated with demographic factors such as gender, ethnicity, age, and disability status (American Psychological Association Task Force on SES, 2007). Adler and Snibbe (2003) found that many studies on race and ethnicity do not properly control for SES in analyses, (i.e., there are no apparent racial and ethnic differences when SES is controlled for). Ensminger et al. (2003) conducted a meta-analysis of four decades of research on Black children, and found that 23% of the studies confused SES and race, comparing low SES Black students to middle income White students.

Ostrove and Cole (2003) state that SES is often not examined as a direct effect, but rather a control variable. “This practice is problematic because whereas controlling for social class may yield less biased estimates, it does not address whether the nature of the relationships or mechanisms among the study variables are mediated or moderated by social class,” (Diemer et al., 2012, p. 12). Even when SES is controlled for, there is a lack of information on its assessment tool and an explanation of its effect to theoretical models (Diemer et al., 2012). The American Psychological Association Task Force on SES (2007) cautions the researcher to consider the manner in which a question is asked, in that this can skew results; SES indicators are related but are not interchangeable. There must be a consideration of how questions can implicate results (Sweeney, 2015).

Measuring SES

Mueller and Parcel (1981) posit that the best method to measure SES is through the use of occupation-based measures, such as the Duncan Socioeconomic Index (SEI) and the Sigel Prestige Scale. The Duncan SEI was an index designed in the 1960s to rate the socioeconomic influence of occupations indicated by the Census (Featherman & Hauser, 1977). The index incorporates data on the pay and attestation of occupations in a mathematical equation that predicts prestige (Hout et al., 2012). The Sigel Prestige Scale is used in sociological studies and is based upon the supposition that jobs are socially delineated, and that the general public's perception of prestige underscores the social ranking and reflects socioeconomic class (Mueller & Parcel (1981).

Mueller & Parcel (1981) also recommend measuring education level (number of years of education) and income (before-tax income for the head of household) as a measure of SES. Providing survey respondents with salary ranges will likely result in greater participation, however salary ranges should be narrow and include categories for a broad range of income. However, Bollen et al. (2001) state that occupation, education, and salary should be considered independently from one another, as each is a measure of a different facet of SES.

Sirin (2005) recommends that a researcher decide on either individual or aggregated data to determine SES. Aggregated data can be based on the school that a child is enrolled in (Caldas & Bankston, 1997) or the neighborhood of residence (Brooks-Gunn et al., 1997). It should be noted that aggregated school and neighborhood SES data cannot be used to generalize about individual level SES (Sirin, 2005). Neighborhood level poverty indicators emphasizes basic standards of living based on societal standards (Iceland, 2003), and is probably best used as an indicator of adolescent exposure to aberrant behavior from peers and members of the community (Diemer et al., 2013).

Educational attainment is a resource-based measure comprised of poverty measures (income, wealth, and years of education completed) and material deprivation (lack of resources) (Diemer et al., 2013). Diemer et al. (2013) recommend that educational attainment data should be collected directly from a parent, however, it can be a good measure of SES when surveying youth. Youth responses on parent educational attainment tend to be less biased than reports of family income, wealth, or occupational prestige (Diemer et al., 2013).

Food insecurity is a relative poverty measure that is based on subjective perceptions of what being poor means, as well as one's experiences and adaptations to being poor (Diemer et al., 2013). A relative poverty indicator relies on data in regards to relative hardship, living standards, and resource deprivation (Iceland, 2003). The United States Department of Agriculture (USDA) Economic Research Service (2021) states that 10.5% of households in the United States were food insecure during 2020, meaning that families were unable to secure enough food for all household members due to lack of money or other resources. The Congressional Research Service (2021) states that data on food insecurity among college students is not reported on by the federal government, therefore it is unknow how many students are affected by inadequate food resources. However, some studies have indicated that college students do experience food insecurity, especially among those enrolled in two-year institutions and from households with low income (Congressional Research Service, 2021). The USDA offers food security surveys for adults and youth (ages 12 and older) that are adaptable for research context, as well as a coding tool for responses (U.S. Department of Agriculture

Economic Research Service, 2021). Diemer et al. (2013) recommend the food surveys from the USDA for a broad of adult and adolescent populations as a relevant measure of SES.

Summary

This chapter has explored the individual and social constructs that are important to the development of STEM identity, and how those constructs may affect STEM choice and long-term persistence which contributes to the production of qualified professionals to fill the numerous jobs in the STEM pipeline. Socioeconomic status has been controlled for in many of the studies mentioned in this review, however, there are drawbacks in how SES was incorporated into the studies. There is still a need for an in-depth analysis, and understanding of, the impact of SES on student experiences and the development of self as a competent contributor in STEM. Such an understanding could result in the cultivation of more effective responses from postsecondary institutions to provide interventions aimed at developing individual interest and a strong sense of capability in STEM.

Chapter III: Methodology

The purpose of this research was to study SES as a direct effect on the development of an individual's STEM identity, choice, and persistence. This study employed a mixed-methods approach. Quantitative data was collected from students at a community college and a regional comprehensive university. Each educational institution served students in the same geographic region, offering an intimate snapshot of the impacts of SES on students within an economically poor region of the state. All students with a declared major in STEM at each institution was invited to participate in the study. Quantitative data was collected by survey to create a model for STEM identity, choice, and persistence and to identify socioeconomic status. Low SES for the purposes of this study was defined as students who were Pell eligible and or food insecure. All student survey participants were invited to join a focus-group interview. Focus-groups were conducted to learn more detail about students' experiences in STEM, including the development of a STEM identity, choice, and plans of persistence in STEM-related degree programs and career fields.

Research Questions and Hypotheses

R1. What is the relationship between STEM identity and socioeconomic factors?

H_A: Students from low SES will have less developed (weaker) STEM identities.

H_0: SES will have no effect on the development of STEM identity.

R2. Do students of low socioeconomic status have different experiences in STEM?

H_A: Students from low SES will have fewer positive experiences in STEM.

H_0: SES will not impact the experiences in STEM.

R3. How does socioeconomic status impact persistence for STEM majors in postsecondary education?

H_A: SES has a direct impact on students' plans for persistence in postsecondary STEM education.

H_0: SES will not impact students' plans for persistence in postsecondary STEM education.

Research Design

A mixed-methods design was chosen under the supposition that the employment of both quantitative and qualitative data would yield a more comprehensive insight into the research questions than either method alone. Creswell and Guetterman (2019) state that the use of mixed-methods research can be a good approach to build upon the fortitudes of both qualitative and quantitative data. Statistical analysis of quantitative data can yield results that can be helpful in describing trends for a large population. Focus-group interviews provide qualitative data that can provide real sentiments of individuals within a study, which can emphasize differing perspectives and create an overall picture of the research problem (Creswell & Guetterman, 2019). Greene and Caracelli (1997) declare that evaluating the quantitative outcomes of a study in combination with the qualitative process can produce an intricate portrait of social phenomena (i.e., the impact of SES on the development of STEM identity, choice, and persistence). Hence, using a mixed-methods approach allows the researcher to provide alternative perspectives in a study (Creswell & Guetterman, 2019).

Creswell and Guetterman (2019) state that once a researcher has identified a study as mixed methods, the next step is to decide the design of the study. Important points to consider at this step are intent, timing, and emphasis. Intent refers to whether or not the researcher will be comparing databases, use one data set to validate another data set, or to gain a broader understanding of the research problem. Timing is a matter of deciding if the quantitative or qualitative data will be collected first, second, or concurrently. And emphasis is a reference to whether the researcher chooses to prioritize the quantitative or qualitative data, or if the data will be analyzed equally (Creswell & Guetterman, 2019).

The research design employed for this dissertation was Creswell's and Guetterman's (2019) explanatory sequential design. Using this two-phase model, quantitative data was initially collected followed by qualitative data to expound upon the quantitative results. Creswell and Guetterman (2019) state "the rationale for this approach is that the quantitative data and results provide a general picture of the research problem; more analysis, specifically through qualitative data collection, is needed to refine, extend, or explain the general quantitative picture" (p. 553). The focus-group questionnaire was designed to ask open-ended questions that could not be answered with one word, and prompted the participants to reflect on their personal experiences and to engage in a conversation (Kreuger & Casey, 2001)

SES has been largely studied as a control variable in the development of STEM identity, choice, and persistence rather than as a direct effect. Analyzing both quantitative and qualitative data may produce a more thorough understanding of the research questions. This can be achieved by initially using quantitative data to develop a survey instrument (i.e., a research survey model for assessing STEM identity, choice, and persistence). Quantitative analysis of the survey instrument was used to structure focus-group interviews. Finally, an analysis of qualitative data from open-ended focus-group interviews was conducted to garner a more detailed understanding of the impact of SES for the survey model (Creswell & Guetterman, 2019).

Setting and Sample

The research was conducted at a community college and regional comprehensive university in a rural region of northwest Tennessee. Upon IRB approval from each institution, the principal investigator submitted requests to the offices of institutional research for a list of student names and emails that were currently enrolled in a STEM field. For the purposes of this study, the following were included as a STEM field: computer science, biology, agriculture, engineering, mathematics, chemistry, geoscience, physics, health sciences, STEM secondary education, and veterinary science and technology. A total of 785 student names and emails were obtained from the community college and 1646 students were obtained from the regional university. All students were contacted via their school email and asked to voluntarily participate in the study.

Risk

There was risk of students being identified and targeted as students from low-income households, which could carry a negative consequence in terms of causing embarrassment. However, to circumvent this problem, there was no instance in which a participant had to share written or verbal information about their socioeconomic status to their peers.

There was a risk associated with loss of confidentiality for all research participants. However, all personally identifying information collected by the researcher was securely stored on the researcher's personal computer and flash drive, both protected with a passcode. The data was not used for other studies, and only coded data was shared in written communication of the research results.

Anonymity

All information obtained from the research participants remained confidential, and no personal identifying information was shared. All participant data remained inaccessible to everyone except the principal researcher. Information was not be shared by the researcher to anyone and all data was coded (Table 1) so that it could not be used to identify a participant by name, SES status, or survey responses.

Table 1

Participant Coding for Data Analysis

Demographic factor	Coding
Student	Arabic numeral
School	1 = community college 2 = university
Ethnicity	1 = Hispanic or Latino 2 = Not Hispanic or Latino
Race	1 = American Indian or Alaska Native 2 = Asian 3 = Black or African American 4 = Native Hawaiian or Pacific Islander 5 = White
STEM major	1 = health science 2 = computer science 3 = biology 4 = pre-health profession 5 = engineering 6 = agriculture 7 = veterinary science & technology 8 = math 9 = secondary education STEM 10 = chemistry 11 = geoscience 12 = physics
Gender	1 = male 2 = female
Pell eligibility	1 = Pell eligible 2 = not Pell eligible
Food security	1 = high food security 2 = marginal food security 3 = low food security 4 = very low food security

Research Instruments

The research instruments used in this study were the U.S. Adult Food Security Survey and the STEM Identity Model Survey. The food security survey was used as a measure of socioeconomic status and the STEM survey was used to create a model for STEM identity, choice, and persistence.

U.S. Adult Food Security Survey

The USDA defines food security as the ability to secure dependable access to an adequate amount of to sustain a healthy and active lifestyle (Nord et al., 2009). Food insecurity is a relative poverty measure that is based upon an individual's perception of what poverty is, and their own experiences and adaptations to living in poverty. Iceland (2003) states that the focus of this measure is on overall deprivation, living standards, and resource deprivation. The U.S. Adult Food Security Survey (Appendix B) is a questionnaire about food inadequacy, its quality, and a decrease in food consumption (Nord et al., 2009). Survey data is used to classify households as food secure or insecure. The survey is "recommended for use with a broad spectrum of the adult population. Potential for use with adolescent and child populations, with appropriate modifications. Useful for research and policy purposes" (Diemer et al., 2012 p. 22).

The U.S. Food Adult Security Survey responses were identified as either negative, positive, or missing, and assigned a code. The codes were summed and equal to a value from zero to ten on the household food security scale. The household food security range relates to a food security prestige rank or category (Table 2).

Table 2

U.S. Food Adult Security Survey Coding

Question number	Question	Negative Response (Code = 0)	Positive Response (Code = 1)	Missing Data (Code = .)
H1	Concerned food would run out	Never true	Often true; Sometimes true	Don't know or Not answered
H2	Purchased food did not last	Never true	Often true; Sometimes true	Don't know or Not answered

H3	Unable to afford to eat balanced meals	Never true	Often true; Sometimes true	Don't know or Not answered
A1	Adult(s) cut or skipped meals	No (or screened out at stage 1)	Yes	Don't know or Not answered
A1a	# of skipped meals in last 30 days by adult(s)	Less than 3 days[3]	3 days or more	Don't know or Not answered
A2	You ate less than you felt you should	No (or screened out at stage 1)	Yes	Don't know or Not answered
A3	You were hungry but you didn't eat	No (or screened out at stage 1)	Yes	Don't know or Not answered
A4	You lost weight due to lack of food	No (or screened out at stage 1)	Yes	Don't know or Not answered
A5	Adult(s) did not eat for an entire day	No (or screened out at stage 1 or 2)	Yes	Don't know or Not answered
A5a	3 days in past 30 days adult(s) did not eat for an entire day	Less than 3 days	3 days or more	Don't know or Not answered

Note. Food Security Status Level [3]

Food Security Status Level. Survey respondents with a raw score of zero were classified as high food security, meaning that there were no indications with barriers to food access. A raw score of 1-2 equated to marginal food security. This signaled that there were one or two affirmative indicators, usually of concerns with lack of a sufficient supply of food in the home, and either little or no modifications in food intake or diet. A score of 3-5 was an indication of low food security amid adults. Low food security signifies a diminished quality of food, but little or no indication of a reduction in food consumption. A score of 6-10 was an indicator of very low food security amid adults and signified affirmative responses on multiple indicators of reduced food consumption and fractured eating patterns (U.S. Department of Agriculture Economic Research Service, 2021). The U.S. Department of Agriculture Economic Research Service (2021) states that 10.5% of households in the United States were food insecure in 2020; 6.6% experienced low food security and 3.9% had very low food security. Food insecurity affected 7.6% of households with children.

STEM Identity Model Survey

The STEM identity model was adapted from Carlone and Johnson’s (2007) science identity model, encompassing performance, recognition, and competence. Survey questions were developed to investigate respondents’ social demonstrations of proper communication and use of STEM-specific tool (performance), respondents’ perceptions of self as a STEM person, as well as acknowledgement by others as such (recognition), and knowledge and comprehension of STEM content (competence) (Appendix C). Actual survey questions were adapted from a STEM Career Interest Survey (STEM-CIS) (Kier et al., 2013). Thus, the survey was used as a measurement for STEM identity (performance, recognition, and competence), as well as STEM choice and persistence (Table 3). Response types and question wording were varied to ensure more reliable responses from participants. Carlone and Johnson correlated science identities with race, ethnicity, and gender, however, this study examined the effect of SES on STEM identity, as well as choice and persistence. This was accomplished by identifying survey participants in high- and low-SES groups and coding their responses for comparative analysis.

Table 3

Item Coding for STEM Survey

Item Number	Question	Model Component
S1	I can do well in my science classes.	R
S2	I am able to complete assignments in my science classes.	R
S3	I plan to use science in my future career.	Ch
S4	I work hard in my science classes.	Ch, Ps
S5	Science will help me in my future career.	Ps
S6	My professor thinks that I am good at science.	R
S7	I enjoy discussing science topics with others.	Pf
S8	I am knowledgeable about some science topics.	Co
S9	I understand the science I have studied in school.	Co
S10	I feel confident in my ability to learn science.	R
S11	My friends and family think I am good at science.	R
S12	I would like to have a science job in the future.	Ps
M1	I am able to do well in my math classes.	Pf
M2	I am able to complete assignments in my math courses.	R
M3	I plan to use math in my future career.	Ch
M4	I work hard to do well in my math classes.	Ch, Ps
M5	Math will help me in my future career.	Ps
M6	Teachers I have had in the past think I am good at math.	R
M7	I like talking to people about math.	Pf
M8	I know a lot about some math-related topics.	Co
M9	I understand the math I have studied in school.	Co
M10	I feel confident in my ability to learn math.	R
M11	My friends and family think I am good at math.	R
M12	I would like to have a math in the future that is math-related.	Ps
M13	I like to participate in activities or games that involve math.	Pf
T1	I am able to learn new kinds of technologies.	R
T2	I plan to use technology in my future career.	Ch
T3	I am willing to learn about new technologies that will help me in school.	Ps
T4	Learning about new technologies will help my do lots of different types of jobs.	Ps
T5	I am able to get better grades when I use technology at school.	R

T6	I like to use technology for class work.	Ch
T7	I am interested in careers that use technology.	Ch
T8	I feel comfortable talking to people about using technology.	Pf, Co
T9	Teachers I have had in the past think I am good at using technology.	R
T10	My friends and family think I am good at using technology.	R
T11	I like to participate in activities that use technology.	Pf
E1	I am able to do well in activities that involve engineering.	R
E2	I plan to use engineering in my future career.	Ch
E3	I will work hard on activities at school that involve engineering.	Ch, Ps
E4	If I learn a lot about engineering, I will be able to do lots of different types of careers	Ps
E5	My friends and family think I am good things that involve engineering.	R
E6	My professor thinks I am good at tasks that involve engineering.	R
E7	I like to participate in activities that involve engineering.	Pf
E8	I feel confident in my ability to learn about engineering.	Ps

Note. Ch – choice; Co – competence; Pf – performance; Ps – persistence; R—recognition.

Questionnaires, Interviews, Focus Groups

All STEM-declared students enrolled during the spring 2022 semester from a community college and regional university were contacted via their school email and invited to complete the STEM interest survey (Appendix C) a within a 14-day period, and two follow-up reminder emails were sent (at days 5 and 10). Students' responses were coded for STEM identity, choice, and persistence. The STEM survey asked respondents to self-report Pell eligibility status and food security status (Appendix B), race, ethnicity, and gender. All survey participants were invited to participate in the virtual focus-group interview. See Appendix D for the focus-group interview protocol and Appendix E for the focus-group interview questions.

Data Security

All data collected from each school's office of institutional research was stored on the researcher's personal computer and locked with a passcode. All quantitative and qualitative student data, and all focus-group recordings were stored on the researcher's personal computer and external storage device, and all respondents were coded to decrease the likelihood that participants could be identified by non-participants by race, ethnicity, gender, SES status, or survey responses. All data files were saved with passcodes.

Study Variables

The independent categorical, ordinal variable in this study was SES (categorical in that it was divided into low-SES and non-low SES, and ordinal in that the data is hierarchical). SES was determined by Pell eligibility and food security status (i.e., food secure or food insecure). The categorical dependent variables used in this study were indicators of STEM identity, choice, and persistence, as determined by the STEM survey (these data were nominal in that there was no hierarchy in the data). Variables that were controlled for were gender, and race and ethnicity. The independent and dependent variables were analyzed for two separate groups, student enrolled in a community college and a regional university.

Data Analysis Procedures

Data was analyzed using a two-phase explanatory sequential design process (Creswell and Guetterman, 2019). The Likert-scale STEM survey responses were analyzed first, followed by the qualitative analysis of the focus-group interviews. The purpose of this approach was to use the quantitative data to establish a general picture of the research problem, then expound upon that picture with qualitative analysis.

Quantitative Data Analysis Procedures

The STEM survey responses were coded for identity, choice, and persistence. Coded questions for STEM identity were: Recognition (S1, S2, S6, S10, S11; M2, M6, M10, M11; T1, T5, T9, T10; E1, E5, E6); Competence (S8, S9; M8, M9; T8); and Performance (S7; M1, M7, M13; T8, T11; E7). Coded questions for STEM choice were: S3, S4; M3, M4; T2, T6; E2, E3.

Coded questions for STEM persistence were: S4, S5, S12; M4, M5, M12; T3, T4; E3, E4, E8. (Note: S, M, T, and E denotes science, math, technology, and engineering, respectively).

Survey items were analyzed by content (science, math, technology, and engineering) subscale using regression analysis to identify a predictor variable. Each category of the survey was used as a layer of analysis and linear regression with the dependent variables used to identify the best fit model for STEM identity, choice, and persistence.

Dummy variables were constructed in SPSS v. 28 for high food security, marginal food security, low food security, and very low food security as predictor. From the menu bar in variable view, the researcher selected *Transform* > *Recode into Different Variables.* A dialog box for *Recode into Different Variables* appeared with the variables in the left-hand side of the dialog box. The researcher selected *Food Security* from the list of variables and the right-arrow button was clicked to move the variables to the *Input Variable > Output Variable box.* The name of the dummy variable (i.e., high food security) was typed in the *Name* box in the *Output Variable* field. Next, *Old and New Values* was selected. A dialog box for *Recode into Different Variables: Old and New Values* appeared. In the *Old Value* field, the researcher typed “1” in the Variable box for the first dummy variable (i.e., high food security). For *New Value*, the researcher entered “0” in the *Value* box (this is the value that was assigned to all other food security values). The researcher selected Add > Continue > Okay. In *Variable View*, the researcher selected the new dummy variable (i.e., high food security) and changed variable *Measure* to *Nominal*. The researcher selected *Value Labels*. In the *Value* box, the researcher typed “1” and in the *Label* box typed the name of the dummy variable (i.e., high food security). The researcher selected *Add*. Next, the researcher typed “0” in the *Value* box and “not high food security” in the *Label* box, and then selected *Add* (BrunelASK, 2013). The steps were repeated for marginal food security, low food security, and very low food security.

Qualitative Data Analysis Procedures

Inductive narrative analysis was used to qualitatively understand participants’ individual stories discussed during focus-group interviews. Inductive reasoning involved an analytic approach and questions to identify the central meanings in the data relevant to the research questions. The analysis outcome was used to reveal pertinent subject matter in regards to the research questions, as well as a presentation of the characterization of the most important themes (Thomas, 2006). Inductive analysis strategies included data analysis driven by the research objectives, in which themes or categories were identified to further investigate. This was accomplished from a direct analysis of the raw data, and reading and rereading each interview transcription. Key themes or categories were identified and coded to construct concise sections or tiers that illuminated the key points related to the research objectives (Thomas, 2006).

Focus Group Analysis Procedures

All student survey participants were contacted via email and provided a Google form link to indicate their preference to participate in a focus-group interview. The Google form offered multiple days and times for student participation. See Appendix D for the focus-group protocol that was employed, and Appendix E for the focus-group questions.

The focus-group interviews were conducted using Zoom technology and recorded. The focus-groups were automatically transcribed with AI Notetaker by Fathom (a free app for Zoom), and transcriptions were sent to participants via their school email to verify for accuracy. Next, each transcription was annotated as a means to code (identify trends and patterns) the qualitative data. Next, trends in the qualitative data were aligned with quantitative data to connect the underlying themes in a cohesive manner. The data segments were grouped into a hierarchical system of most to least prominent to align quantitative and qualitative data.

Reliability

The STEM survey was administered to students one time and the consistency of their responses across the items was measured. The researcher estimated the internal consistency of the Likert scale items for STEM identity, choice, and persistence using Cronbach's alpha in SPSS v. 28. To calculate Cronbach's alpha, the researcher selected *Analyze* > *Scale* > *Reliability Analysis* from the menu bar. A *Reliability Analysis* dialog box appeared with the variables in the left-hand side of the dialog box. The variables for *STEM identity* were selected and the right-arrow button was clicked to move the variables to the *Items* box. The researcher clicked *Statistics*. The *Reliability Analysis: Statistics* box appeared, and under the *Descriptives for,* the researcher selected *Item* and *Scale* > *Continue* > *OK* (Yockey, 2018). The steps were repeated for STEM choice and STEM persistence.

The researcher constructed the study with consistent protocols and documentation of qualitative data. The Likert-scale items for the STEM survey and focus-group questions were developed by the researcher. Protocols for the focus-groups were developed and consistently implemented and documented. All quantitative and qualitative data was coded with enough information that the study could be replicated by another researcher. Each focus-group meeting was held via Zoom and recorded. During each session, the researcher repeated back the statements that were made by participants to ensure that the statement was understood correctly. The researcher created a transcript of what each focus-group participant said and verified that the transcript was accurate with each individual participant via email.

Chapter IV: Findings and Analysis

The purpose of this study was to investigate the relationship between the development of a STEM identity, students' decision to pursue a STEM-related field, and their persistence to complete academic requirements with socioeconomic status (Pell eligibility or food security). This chapter confers the results of the findings. Quantitative data was collected via survey (Appendix B and Appendix C) and analyzed using IBM SPSS v. 28. The survey data was analyzed for descriptive statistics and regression analysis. Frequency statistics were collected for the demographic categorization of the sample population. Qualitative data was collected via focus-group interviews (Appendix E) and was inductively analyzed to identify themes in the data relative to the research questions.

Research Questions and Null Hypotheses

The research questions and null hypotheses for this research are listed below. The tools used for the mixed-methods study were a STEM survey, USDA Food Security Survey, and virtual focus-group interviews that were conducted and recorded using Zoom technology. The research questions and hypotheses were:

Research Question 1: What is the relationship between STEM identity and socioeconomic factors?

Null Hypothesis 1: There is no relationship between STEM identity and socioeconomic factors.

Research Question 2: Do students of low socioeconomic status have different experiences in STEM?

Null Hypothesis 2: There will be no difference in the STEM experiences of students from low socioeconomic status.

Research Question 3: How does socioeconomic status impact persistence for STEM majors in postsecondary education?

Null Hypothesis 3: Socioeconomic status will not impact students' plans for persistence in postsecondary education.

Quantitative Sample and Study

Participants were selected for survey analysis from a community college and a regional university, and were contacted via their school email account to solicit participation. A total of 31 males (32.6%) and 64 females (67.4%) completed the survey (n = 95); (31.6% from the community college and 68.4% from the university). The sample included 89.4% White, 8.5% Black, 2.1% Asian, and 95.7% not Hispanic or Latino (Table 4).

Table 4

Gender, Race, and Ethnicity of Survey Participants

Gender	Race	Frequency	Ethnicity	Frequency
Male	White	28	Latino	1
	Black	2	Not Latino	30
	Asian	1		
Female	White	56	Latino	3
	Black	6	Not Latino	60
	Asian	1		

The percentage of STEM majors reported were as follows: 19.1% health sciences, 16% computer science, 20.2% biology, 12.8% engineering, 17% agriculture, 7.4% veterinary science and technology, 2.1% mathematics, 1.1% secondary STEM education, 2.1% chemistry, 1.1% geoscience, and 1.1% physics (Table 5).

Table 5

Frequency of STEM Majors Among Survey Participants

STEM Major	Frequency of males (n = 31)	Frequency of females (n = 63)	Total number (n = 94)
Computer Science	9	6	15
Biology	6	13	19
Agriculture	4	12	16
Engineering	8	4	12
Math	1	1	2
Chemistry	1	1	2
Geoscience	1	0	1
Physics	0	1	1
Health Sciences	0	18	18
STEM Secondary Ed	1	0	1
Vet Science & Tech	0	7	7

One-half of respondents were Pell eligible, 40.4% were Pell ineligible, and 9.6% preferred not to answer (Table 6). Food security among participants showed a total of 32.7% of respondents with low or very low food security (21.1% and 11.6%, respectively), 22.1% with marginal food security, and 45.3 % with high food security (Table 7).

Table 6

Pell Eligibility of Survey Participants

Pell Eligibility	Male	Female	Total Number
Eligible	16	31	47
Not eligible	7	31	38
Prefer not to answer	7	2	9

Table 7

Food Security of Survey Participants

Food Security Status	Male	Female	Total Number
High	14	29	43
Marginal	8	13	21
Low	5	15	20
Very low	4	7	11

STEM Survey Item Statistics

A Likert scale was used for the STEM survey, and consisted of a set of science, math, technology, and engineering questions. There was a total of 12 science questions (M = 4.3); 13 math questions (M = 3.7); 11 technology questions (M = 4.2), and 8 engineering questions (M = 3.3). STEM survey questions were coded for recognition (M = 3.9), competence (M = 3.9), performance (M = 3.6), choice (M = 4.0), and persistence (M = 4.0).

The reliability of the STEM survey items was conducted for STEM identity, STEM choice, and STEM persistence by calculating Cronbach's alpha for each variable (Yockey, 2018). The coefficient alpha for STEM identity was .91. The means of the individual items ranged from 3.12 to 4.50, with a mean on the total scale of 99.56 (*SD* 13.22). The mean and standard deviation of the items for STEM identity are reported in Table 8. Overall, the coefficient alpha for STEM identity indicated an estimate with a high degree of internal consistency reliability for student responses (Yockey, 2018). Thus, the model was an excellent measure of STEM identity.

Table 8

Mean and Standard Deviation of STEM Identity Items

Item	*M*	*SD*
s1	4.2211	.74632
s2	4.4947	.58115
s6	3.7474	.71412
s7	4.1263	.86593
s8	4.2421	.67973
s9	4.0632	.79641
s10	4.3263	.72114
s11	4.1684	.83351
m1	3.8632	1.09749
m2	4.2421	.76792
m6	3.8105	1.05482
m7	2.6316	1.15825
m8	3.2737	1.08610
m9	3.9053	1.04244
m10	3.8421	1.11389
m11	3.7789	1.10298
m13	2.9474	1.28302
t1	4.3684	.70034
t5	4.3158	.76162
t8	4.0737	.86593
t9	3.9263	.85355
t10	4.2316	.76426
t11	4.1368	.79373
e1	3.1368	1.12619
e5	3.1579	1.13283
e6	3.1158	.93243
e7	3.2737	1.15263

The coefficient alpha for STEM choice was .65. The means of the individual items ranged from 2.85 to 4.56, with a mean on the total scale of 32.24 (*SD* 3.84). The mean and standard deviation of the items for STEM choice are reported in Table 9. Overall, the coefficient alpha for STEM choice indicated an estimate with a marginal degree of internal consistency reliability for student responses (Yockey, 2018). Thus, the model was questionable in terms of reliability measuring STEM choice using students' responses.

Table 9

Mean and Standard Deviation of STEM Choice Items

Item	*M*	*SD*
s3	4.5579	.63104
s4	4.4947	.65026
m3	3.9368	.89693
m4	4.3263	.77791
t2	4.2947	.77010
t6	4.2947	.77010
e2	2.8526	1.26296
e6	3.4842	1.15651

The coefficient alpha for STEM persistence was .77. The means of the individual items ranged from 3.04 to 4.57, with a mean on the total scale of 44.23 (*SD* 5.48). The mean and standard deviation of the items for STEM persistence are reported in Table 10. Overall, the coefficient alpha for STEM choice indicated an estimate with a fair degree of internal consistency reliability for student responses (Yockey, 2018). Thus, the model was an acceptable measure for STEM persistence.

Table 10

Mean and Standard Deviation of STEM Persistence Items

Item	*M*	*SD*
s4	4.4947	.65026
s5	4.4737	.75572
s12	4.3368	.80702
m4	4.3263	.77791
m5	3.8105	.90265
m12	3.0421	1.24555
t3	4.5158	.59899
t4	4.5684	.55835
e3	3.4842	1.15651
e4	3.6632	1.05800
e8	3.5158	1.09993

The coefficient alpha for STEM experiences was .87. The means of the individual items ranged from 2.63 to 4.56, with a mean on the total scale of 81.61 (*SD* 10.21). The mean and standard deviation of the items for STEM experiences are reported in Table 11. Overall, the coefficient alpha for STEM experiences indicated an estimate with a good degree of internal consistency reliability for student responses (Yockey, 2018). Thus, the model a good measure for STEM experiences.

Table 11

Mean and Standard Deviation of STEM Experience Items

Item	*M*	*SD*
s7	4.1263	.86593
m7	2.6316	1.15825
m13	2.9474	1.28302
t8	4.0737	.86593
t11	4.1368	.79373
s1	4.2211	.74632
s2	4.4947	.58115
s3	4.5579	.63104
s10	4.3263	.72114

s11	4.1684	.83351
m2	4.2421	.76792
m6	3.8105	1.05482
m10	3.8421	1.11389
m11	3.7789	1.10298
t1	4.3684	.70034
t5	4.3158	.76162
t9	3.9263	.85355
t10	4.2316	.76426
e1	3.1368	1.12619
e5	3.1579	1.13283
e6	3.1158	.93243

Quantitative Analysis of SES and STEM Identity

Research Question 1: What is the relationship between STEM identity and socioeconomic factors?

Null Hypothesis 1: There is no relationship between STEM identity and socioeconomic factors.

STEM survey items that measured student STEM identity were coded questions for competence, performance, and recognition. The coded questions for competence were: S8, S9, M8, M9, and T8. Coded questions for performance were: S7, M7, M13, T8, and T11. Coded questions for recognition were: S1, S2, S3, S10, S11, M2, M6, M10, M11, T1, T5, T9, T10, E1, E5, and E6.

The researcher used regression analysis to determine whether socioeconomic status was a significant predictor of STEM identity. Socioeconomic status was studied using Pell eligibility and food security. Results for Pell eligibility as a predictor variable of STEM identity were not significant, with β = .07, $t(92)$ = .64, p = > .05, and R^2 =0.

Regression analysis for high food security as a predictor variable was not a significant with β = .09, $t(93)$ = .85, p = > .05, and R^2 =.01. Marginal food security as a predictor variable of

STEM identity was not significant with *β* = -.05, *t*(93) = -.52, *p* = > .05, and R^2 =0. Low food security as a predictor variable for STEM identity was not significant with *β* = -.06, *t*(93) = -.56, *p* = > .05, and R^2 =0. Very low food security as a predictor variable for STEM identity was not significant with *β* = -.03, *t*(93) = -.33, *p* = > .05, and R^2 =0. Therefore, the researcher failed to reject the null hypothesis.

Quantitative Analysis of SES and STEM Experiences

Research Question 2: Do students of low socioeconomic status have different experiences in STEM?

Null Hypothesis 2: There will be no difference in the STEM experiences of students from low socioeconomic status.

STEM survey items that measured student STEM experiences were coded questions for performance and recognition. The coded questions for performance were: S7, M7, M13, T8, and T11. Coded questions for recognition were: S1, S2, S3, S10, S11, M2, M6, M10, M11, T1, T5, T9, T10, E1, E5, and E6.

The researcher used regression analysis to determine whether socioeconomic status was a significant predictor of student STEM experiences. Socioeconomic status was studied using Pell eligibility and food security. Results for Pell eligibility as a predictor variable of STEM experiences were not significant, with *β* = .07, *t*(92) = .63, *p* = > .05, and R^2 =0.

Regression analysis for high food security as a predictor variable was not a significant with *β* = .09, *t*(93) = .90, *p* = > .05, and R^2 =.01. Marginal food security as a predictor variable of STEM experiences was not significant with *β* = -.05, *t*(93) = -.45, *p* = > .05, and R^2 =0. Low food security as a predictor variable for STEM experiences was not significant with *β* = -.02 *t*(93) = -.18, *p* = > .05, and R^2 =0. Very food security as a predictor variable for STEM experiences was not significant with β = -.06, $t(93)$ = -.59, p = > .05, and R^2 =0. Therefore, the researcher failed to reject the null hypothesis.

Quantitative Analysis of SES and STEM Persistence

Research Question 3: How does socioeconomic status impact persistence for STEM majors in postsecondary education?

Null Hypothesis 3: Socioeconomic status will not impact students' plans for persistence in postsecondary education.

STEM survey items that measured student STEM experiences were coded questions for persistence. The coded questions for S4, S5, S12, M4, M12, T3, T4, E3, and E8.

The researcher used regression analysis to determine whether socioeconomic status was a significant predictor of STEM persistence. Socioeconomic status was studied using Pell eligibility and food security. Results for Pell eligibility as a predictor variable for STEM persistence was not significant with β = .10, $t(92)$ = .95, p = > .05, and R^2 = .01.

Regression analysis for high food security as a predictor variable was for STEM persistence was not significant with β = .11, $t(93)$ = 1.0, p = > .05, and R^2 =.01. Marginal food security as a predictor variable for STEM persistence was not significant with β = -.07, $t(93)$ = -.65, p = > .05, and R^2 =.01. Regression analysis with low food security as a predictor variable for STEM persistence was not significant with β = -.07, $t(93)$ = -.65, p = > .05, and R^2 = 0. Very low food security as a predictor variable for STEM persistence was not significant with β = -.01, $t(93)$ = -.11, p = > .05, and R^2 = 0. Therefore, the researcher failed to reject the null hypothesis.

Qualitative Sample and Study

The initial STEM and SES survey provided students with the opportunity to indicate their willingness to participate in focus groups with the researcher about their STEM experiences;

20% (n = 19) of students indicated yes, 35.8% (n = 34) indicated no, and 44.2% (n = 42) indicated maybe. A total of 61 students (those whose response was yes or maybe) were invited via their school email to participate, and 32.8% (7 from the community college and 13 from the regional university) took part in the follow-up focus group. The participants were composed of 9 males and 11 females; 2 freshman, 8 sophomores, 5 juniors, and 5 seniors. Students' majors were as comprised of 25% computer and information systems, 40% biology, 5% STEM secondary education, 10% health sciences, 10% agriculture, and 10% math (Table 12).

Table 12

Characteristics of Focus-Group Participants

STEM Major	Frequency of males (n = 9)	Frequency of females (n = 11)	Total number (n = 20)
Computer Science	4	1	5
Biology	2	6	8
STEM Secondary Ed	1	0	1
Health Sciences	0	2	2
Agriculture	1	1	2
Math	1	1	2

A total of four focus-groups were conducted via Zoom. The first focus-group consisted of 3 student participants, the second was made up of 7 students, the third had a total of 6 students, and the fourth had a total of 4 students. Refer to Appendix D for the Focus-Group Protocol and Appendix E for the Focus-Group Questions that were used during each session. The sessions ranged in duration from 20 minutes to 45 minutes.

Focus-Group Findings

The outcome from the focus-group sessions underscored several factors that were influential in a student's STEM journey, including altruism, the positive impact of family, friends, and professionals, recognition, academic experiences, and personal interest. The impact of SES was a poignant determinant of school choice, while individual study skills, self-discipline, and mental health issues were cited as stumbling blocks to persistence.

STEM Identity, Choice, and Persistence

Familial Influence. Interviewees were asked who had been the most influential person in igniting their interest in a STEM-related field. Fifty percent (n=10) of respondents said a family member (mother, father, uncle) were pivotal in spurring a lasting interest in STEM, 25% identified a teacher or professor, and 25% cited a famous scientist, influencer in a particular field, or a STEM professional as being most influential. A sophomore university student majoring in computer science and information systems said that his mother, a registered nurse, always encouraged his love of computers and technology from a young age. It was her belief in his ability to do well in that area that gave him the intrinsic motivation to pursue a degree in a STEM field.

A female community college student, who will graduate with an Associate's degree with a concentration in pre-occupational therapy said her family's encouragement was what gave her the confidence she needed to pursue a future career as an occupational therapist, and stated:

> I always knew I wanted to do something that was helping people. I didn't exactly know what that would be. I went through a lot of majors before deciding on occupational therapy. I have a lot of family and friends. When I brought up the career choice I was

> considering, they said, “I think you’d be really good at that. You work really well with people.” So, yeah, that’s kind of why I chose it.

Interest. Long-term interest in a STEM field was cited by 40% (n=8) of students as a determining factor for choosing and persisting in a STEM-related academic major. Each of the students described how their interest developed intrinsically over time, investing a great deal of time in learning more about their field throughout their educational careers. A first-year male freshman at the university majoring in computer science and information systems said:

> My interest in the computing field started from a very young age, where I would take apart old computers and rebuild them. I wanted to know how every part worked, and then I developed a strong interest in the software side.

A female university student who is majoring in cell and molecular biology and wants to become a physician’s assistant affirmed that her persistence was a result of past experiences, which also influenced her STEM choice:

> I meet with my cell biology professor to discuss the course material weekly, and he really worked with me. I have also had the same experience with my organic chemistry professor. These two experiences have given me some hope that I can continue my education while facing all of the struggles. They motivate me to keep going and they really do try their best to help me. It makes me feel valued as their student.

Academic Experiences. Thirty percent (n=6) of students indicated the importance of past STEM experiences in shaping their belief that they could have a successful career in a STEM field. A university computer science major in his sophomore year brought out the positive impact of being invited to participate in a cyber security class at a state university after he learned hardware programming in his high school class.

A female senior biology student from the university said that she hopes to obtain a Ph.D. in microbiology. At the time of the interview, she had already applied to five graduate schools and was awaiting acceptance decisions. She stated:

> Getting myself into the lab and in different situations made me realize where my passion was. At first, I thought I wanted to be a surgeon, but as I got more into the lab side of it, I realized that I really liked that aspect. The experiences that I have had in the college lab was what really made me be able to see myself as a scientist. I have also shadowed doctors and realized that I did not want to do that. When I got into the research side, I really loved it, the whole experience.

A female university student majoring in veterinary science and technology said:

> I grew up in a veterinarian's office that my mother worked at and always loved surgery and science, so I knew I wanted to do something in the sciences professionally. In high school I fell in love with the lab during my chemistry classes, which led me to really consider majoring in biology or chemistry. But it was not until I got my current job in an environmental lab that I really saw myself wanting to be a professional in that field and setting.

A female community college student working to advance her career from a licensed practicing nurse to a registered nurse asserted that acknowledging her own competence was a driver in her persistence:

> While I lived in California, I was taking a chemistry class and was struggling a little. During chemistry lab, everything from lecture just clicked. It was an awesome experience to finally get what my instructor was explaining. It made the struggle of going back to school in my forties less overwhelming.

A male computer science major from the university who aspires to be a video game developer explained how a positive STEM experience (i.e., an educator) was a determinant in his STEM choice:

> My pre-calculus teacher in high school was super excited about math and did everything she could to help us understand it. We had lots of examples and not just pure theory and proofs. It made me feel like I could conquer math, which had always been my weakest subject.

A senior wildlife biology major at the university explained how participating (i.e., performing) in an educational extra-curricular course made a strong impact on his perceptions about his competence:

> This past summer I was able to participate in a two-week wildlife techniques course at my university. It made me feel like a true wildlife professional, because I was in the field all-day, learning wildlife and conservation techniques with wild animals.

Recognition. When asked what factors were important in declaring a STEM major in college, 20% (n=5) referred to the significance of the confidence that STEM professionals placed in their ability to succeed in their chosen field. One participant worked for her personal doctor, who encouraged her to pursue a degree in a health science field. While another student cited how impactful it was when he was trusted to teach his peers, stating how it made him feel empowered and capable. A male freshman at the university who is majoring in computer science and wants to become a software engineer stated the positive impact of being recognized as good at math by his professor, saying:

> My math professor told me that I was the only person in all three sections that she taught of that class to make a 100. It made me feel like my efforts had been worth it, and it made me want to continue to work hard to understand and do well.

Altruism. Interviewees were initially asked what made them able to see themselves as a STEM professional. Many responses were altruistic; 20% (n=5) of students made direct comments about wanting to help others or referred to their desire to leave the world better than they found it. And another student voiced their desire to help develop more sustainable practices in their chosen STEM field. A sophomore mathematics major from the university said:

> I would like to teach upper-level math at a high school, like calculus or trigonometry, because that's just what I enjoy the most from the classes I have taken. I hope to reach students on a personal level so they can build those connections and be able to understand the material better. And then I can also motivate them to do well in other subjects and push them to do their best.

Socioeconomic Influence

Interviewees were asked to elaborate on the impact that their socioeconomic impact has had on their educational journey. Most of the respondents said that SES was not a significant determining factor in the development of their STEM identity or in their decision to declare and pursue a STEM-related major. Rather, SES was cited as being a determinant in choosing where to go to school to work towards earning a degree and whether or not they could afford to take a summer class. However, one student did say that his SES did play a major role in him being unable to move on to a 4-year university to complete a bachelor's degree after completing an associate's degree at a community college.

A nontraditional female community college student who had worked to advance her career from LPN to RN brought up a perspective that many younger students may not have experienced, and cited the importance of grants to help her complete her degree. She stated that she had relied on Pell grants and the TN Promise grant to be able to afford to complete her educational journey at the community college. A senior biology major at the university stated that at one time she thought her socioeconomic status would be the determinant in her being unable to continue her education:

> It has been a journey. My parents live in California, both are teachers, and they only pay for my health insurance. I pay for everything else, phone, car, insurance, housing, food. I spent a lot of time making sure I could afford to eat. I worked 30-40 hours per week on top of school my first two years and that was not a good idea. My grades suffered. My health suffered. I sacrificed sleep and eating to work and go to school. My health issues caught up with me and I decided to focus on eating properly. School performance went down. I talked to some professors about my situation. Once I worked at Bayer, I got more doors opened up to me because I had a little bit of experience and I was able to get two

> jobs; one in the chemistry department and one in the biology department and I got close to some of my teachers. At one point I did not think I would be able to go back to school due to financial reasons. I reached out to my professors and they helped me find two scholarships that allowed me to stay enrolled in school. It was not a lot of money but it was enough. Being on campus and having professors listen meant a lot.

Most interviewees, when asked, implicated causes other than socioeconomic status as the biggest barriers in their STEM educational journey, such as specific courses, study skills and discipline, and mental health factors.

Summary

There were five themes that were impactful in the development of a STEM identity and students' choice to pursue a STEM-related major. The themes (ranked from highest to lowest number of mentions) were familial influence, interest, academic experiences, recognition, and altruism. Within each of the main themes, there was a fundamental role in the positive impact of constructing a student's level of competence, thus improving their ability to perform well in a STEM field. The role of SES was emphasized as being an important determinant for school choice, however, it was not a significant predictor of STEM identity, choice, and persistence. These results can promote the development and implementation of proactive strategies to help students mitigate the challenges they face, and accentuate the factors that are most poignant in extrinsically motivating students to persist in a chosen STEM field. Chapter five provides a summary of the findings from the data analysis and its significance to P-20, as well as the limitations of the study, and recommendations for future research.

Chapter V: Conclusion and Discussion

The purpose of this study was to investigate the effects of socioeconomic status (i.e., Pell eligibility and food security) on the development of STEM identity, choice, and persistence at a community college and regional university in northwestern Tennessee. The research questions that directed the study were:

- What is the relationship between STEM identity and socioeconomic factors?
- Do students of low socioeconomic status have different experiences in STEM?
- How does socioeconomic status impact persistence for STEM majors?

Recommendations and conclusions based on this study are addressed in this chapter. Recommendations are provided for improving student recognition, competence, and participation in the postsecondary classroom to improve STEM identity, choice, and persistence. Support will also be made for acknowledging and addressing the impact of recognition of a student in shaping their STEM journey. Study limitations and guidance for future research approaches are discussed for learning more about the impact of socioeconomic status on students' perceptions of STEM identity, choice, and persistence.

Conclusions

The mixed-methods approach of this study yielded a much broader insight into the research questions than either method individually. Quantitative survey data analysis shows that there is not a significant relationship between STEM identity, choice, or persistence with socioeconomic factors (i.e., Pell eligibility and food security). However, qualitative data analysis shows that SES does impact college choice, the ability to continue education past a 2-year degree, and reliance on grants and scholarships to help pay for education. Qualitative data analysis also shows that the development of a STEM identity is positively affected by recognition from others (i.e., educator, relative, or friend), personal perceptions of self-competence in a STEM area, and participation (i.e., performance) in STEM activities. Personal interest and altruistic expectations of improving the lives of others is also a resolute determinant in STEM identity development. These factors are important for postsecondary institutions to consider when creating programs or incentives to increase the number of STEM majors. These factors should also be taken into consideration among STEM schools and departments when determining how to increase the retention and completion of these students.

These results are consistent with Creswell and Guetterman's (2019) assertation that quantitative data can be helpful for identifying trends, while qualitative data can highlight individual perspectives that may not have been evident in statistical analyses. Further, using a mixed-methods approach can result greater overall picture of the social phenomena that may be influential to the research questions (Greene and Caracelli, 1997).

SES and College Choice

Findings from the focus-group interviews revealed that SES was most predictive of college choice. Students chose schools they could most afford based upon the amount of grants and scholarships they could receive. The U.S. Census Bureau (2021) reported that 16% of children under the age of 18 are living in poverty. There are now programs that enable students to obtain an associate's degree at a community college at no cost to students through grants and last-dollar scholarships. As such, there is the potential for a higher enrollment of students from low SES in community colleges compared to universities. The institutions included in this study are illustrative of this, with enrollment of Pell eligible students greater than 14% higher at the community college than at the regional university (Dyersburg State Community College, 2022; University of Tennessee at Martin, 2022).

Recognition, Competence, and Performance

The results of this study are consistent with Carlone and Johnson's (2007) model for science identity based on the role of competence, performance, and recognition. The recognition by peers of the performance of a task by a competent person is a strong driver in the development of a STEM identity (Kane, 2016). Governing the social and cultural practices (i.e., performance) encompassed in STEM is also part of the development process of STEM identity (Barton et al., 2013). Competence and recognition have also been shown to be important in STEM choice for URM (Garcia et al., 2019).

Qualitative data analysis of this study underscores the importance of self-perception as an important determinant in developing competence. Focus-group participants cited the role that family, friends, teachers, and employers had on their development of competence. This is accordant with evidence from previous research that cites culture (Godec, 2018), familial support (Bleeker & Jacobs, 2014; Ortiz et al., 2019), academic experiences (Heilbronner, 2011), and self-efficacy (Bandura, 1986; Sax et al., 2015) in the development of competence.

STEM choice is directly influenced by self-efficacy (van Aalderen-Smeets et al., 2019), and persistence (Cabell, 2020; Mau, 2003). Self-efficacy in math and science courses is associated with STEM choice in community colleges (Evans et al., 2020). Additionally, focus-group participants discussed the positive role of academic experiences in bolstering their STEM journey. This finding is confirmation that academic success is a significant predictor of STEM choice and persistence (Cohen & Kelly, 2019).

Personal Interest and Altruism

Several focus-group respondents voiced their desires to leave the world a better place, help develop more sustainable practices in a particular STEM field, or to help others live a healthier and happier life. This altruistic, or unselfish concern for others, was also cited as an important factor for STEM identity development in a qualitative study of five girls aged 11-12 (Godec, 2018).

Intrinsic interest was a recurrent theme in student persistence, consistent with research from Renninger and Su (2012). Further, investing in more time learning about a topic in STEM enhanced student self-perception, positively impacting plans for persistence. This was also demonstrated in a 1992 study from Wigfield and Eccles. This study did not investigate the timing of interest development, however previous research shows that middle school is the most influential time period to help initiate and aid interest development in STEM (Archer et al., 2010; Hill et al., 2011; Maltese & Tai, 2010).

Several student participants in the focus-group sessions cited the importance of teaching-and-learning practices employed by teachers in the classroom. This adds credence to the research ascertaining that intrinsic student interest can be extrinsically augmented by varying pedagogical practices in the classroom (Lee, 2013). Interest can also vary across student groups. Female and URM students, and students from low SES backgrounds are more likely to lose interest in STEM (Cooper & Berry, 2020; Saw et al., 2018).

Discussion

This study was designed to measure the direct impact of SES on the development of STEM identity, choice, and persistence for postsecondary students. Qualitative data analysis of participant responses showed a clear connection of student recognition, competence, and performance as key indicators of STEM identity development, choice, and persistence among specific STEM fields. Recognition, mentoring, and positive role models strongly influenced identity and choice. And faculty-student relationships appeared to be most impactful in determining persistence. Socioeconomic status seemed to really only be most impactful in student choice of postsecondary educational institution.

P-20 Implications

P-20 embodies the whole of all constituents of the educational system, yet all too often, educational sectors operate as silos. Students experience a multitude of transitions throughout their educational journey. Elementary, middle, and high schools, as well as community colleges and universities do a relatively good job in supporting their students in their “area.” However, there is a lack of resources and programs in place to aid students in their transition from one level to the next. While most educational institutions do offer some assistance, most efforts lack the duration to make any significant impact. Many elementary and middle schools will have a student assembly to congratulate their accomplishments to-date, and then have a short program telling them about the new challenges that lie ahead, offering words of guidance and wisdom. Students in middle and high school will get their schedule for the following academic year, and there is usually a night for parents to learn about their child’s upcoming changes. Community colleges and universities offer orientation classes for new students and their parents, and then barrage them with emails about the multitude of services and programs the school offers. Thus, school districts, administrators, and community stakeholders should include classroom teachers in the collaborative decision-making process when designing programs to facilitate smoother and more effective transitions for students.

A survey at Bowling Green State University indicated that 11% percent of students rarely or never open emails and 72% treated emails from student organizations as spam; 39% don’t always read emails from their academic advisors, and over half do not read emails from academic departments (Straumsheim, 2016). Thus, in many instances, programs and resources may be underutilized by those who could benefit most from them. When asked how resources at school can with planning your educational journey to a STEM career, one focus-group participant said:

> My school has career fairs, professors helped me to find on-campus jobs, my school has met my needs. But I am very extroverted and do not have a problem asking for help. I am passionate about asking people for advice, but introverts may have a hard time with asking for help. We have a lot of resources on campus to help students. I guess it depends on the type of person.

Public school officials often lack financial resources and manpower to address the needs of their students. States make laws that govern these educational institutions, and policies change frequently, often before enough data has been collected to identify their significance. There is also a lack of continuity among districts within a state or region. And schools in areas with high poverty rates are dually disadvantaged with higher teacher turnover, low parental involvement, and even fewer financial resources for their students. Additionally, public schools are data-driven by state mandated assessments to avoid becoming a target school, resulting in classes that teach to a test and eliminating the element of wonder and discovery for the student. Thus, students often lack the opportunity to develop skills and interest in particular disciplines.

Postsecondary institutions offer an abundance of programs and resources for their students. Many of these programs go largely unused by students, and become replaced with different programs. And there are silos within a singular educational institution. Faculty do not always know about what their school offers or how to address students that may need services. Further, faculty tend to segregate themselves into their discipline-specific area. Students are disconnected, distracted, and lack the tools they need to persist, and they, too, segregate themselves into cliques. Everyone knows what they are doing, but not what anyone else is doing. How is it that we can reach our students, discover what they need to be successful, and offer practical long-term resources to them? We need to become one cohesive team. Silos need to be broken down.

A major P-20 implication from this study is the importance for educators, parents, and community, state, and federal officials to come to the table as a team. It is pertinent for all stakeholders to really understand the make-up of the student body of their schools. Education is not a one-size-fits-all, and programs and interventions geared towards improving student performance and retention must be applicable to the student body. Stakeholders need to become intricately involved in their willingness to offer teacher resources and student opportunities to learn more about their industry and how it relates to discipline-specific content in schools.

Another major P-20 implication from this study is the importance of relationships. The role of faculty is pertinent in fostering a sense of belonging among students and encouraging retention and completion (Allen-Ramdial & Campbell, 2014). The faculty's role in cultivating relationships is a key element in developing students' perceptions of their ability to not see themselves as both STEM professional and important contributor in their field. Thus, faculty and staff of postsecondary institutions need to identify the student majors in their departments, and help them identify their strengths, bolster their courage to work on their weaknesses, and encourage and mentor them throughout their educational careers. But it is not enough to stop there. Relationships should allow faculty to really "know" their students. As one university student said:

> ….at one point I did not think I would be able to go back to school due to financial reasons. I talked to some professors about my situation, and they helped me to find on-

> campus jobs. They also helped me find two scholarships. It was not a lot of money but it was enough. Being on campus and having professors listen and be willing to help meant a lot.

Lastly, this study underscores the importance for educational institutions to implement STEM programs and resources in their schools. In the region where this study was conducted, there are fewer schools with STEM programs that anywhere else in the state. The Tennessee STEM Innovation Network (TSIN) works with the Tennessee State Board of Education to improve STEM education in public schools across the state. To date, there are 88 STEM designated schools, however there are only three in the northwest region (Tennessee STEM Innovation Network, 2022), which has a poverty rate higher than the state average. The purpose of TSIN is offer resources to help increase the competence and confidence of public-school teachers by offering professional development and training opportunities. These resources are offered through STEM Innovation Hubs across the state, and are often no-cost to the participants. Increasing the number of teachers who are trained in STEM and excited to teach it to their students can be beneficial in the development of intrinsic student interest in STEM. Long-term interest and participation in STEM can create positive experiences that may enhance the likelihood for student choice in STEM. STEM choice, interest, and participation can lead to persistence. Persistence can lead to completion, which leads to an increase in the number of qualified professionals in the STEM workforce. The implementation of programs like those offered through TSIN could be impactful in reaching students at younger ages and more often, increasing opportunities for STEM identity and long-term interest, and ultimately making differences in the number of students entering the STEM pipeline.

TSIN's model to improve STEM education by offering resources to increase the competency level of classroom teachers has the potential to make direct impacts in the development of STEM identity, students' decisions to pursue STEM, and plans for persistence. Offering discipline-specific training and professional development resources can give teachers the confidence to teach STEM in their classrooms and improve pedagogical practices. Opportunities to practice STEM in the classroom amplifies student competence and perceptions of self-efficacy. Teachers who become subject-matter experts and employ differentiated pedagogical practices produces an environment that is conducive to learning.

The establishment of community partners and their active engagement with teachers and students can bring awareness of the importance of STEM in the local workforce, introduce students to community members that work in those roles, and learn about the skills and knowledge necessary to become qualified for those jobs.

Practical Significance

While the results of this study did not reveal that SES was a significant predictor of STEM identity, choice, and persistence, qualitative data analysis did allude to the impact that SES or food insecurity had for students in their postsecondary journey. Further, many schools in less affluent areas experience lower rates of parental involvement (Velsor and Orozco, 2007). Encouraging the involvement of the parents of K-12 students beyond parent-teacher conferences (i.e., community events, STEM events, and help sessions for the completion of college and FAFSA applications) can embolden the positive impact of parents and family on students' STEM journey (Godec, 2018). Elementary, middle, and high school students who develop a strong STEM identity will be more likely to choose a STEM major upon postsecondary enrollment (Hazari et al., 2010; Wang, 2013). Additionally, providing emotional and academic resources in higher education is an important determinant in STEM identity development and persistence (Ortiz et al., 2019).

The results of this study can be helpful at all levels of education to proactively establish interventions and programs to meet the needs of students that may be at risk due to socioeconomic factors. This may be especially beneficial in areas with a large percentage of students who qualify for FRPL in K-12 schools and for postsecondary adult students who are Pell eligible or may experience food insecurity. An understanding of the challenges that our students face and how they were able to overcome them is important in aiding educators to develop practical and sustainable strategies to help students navigate and prepare for educational transitions from preschool through college graduation and eventually into the workforce (Wang, 2013).

Limitations

Sample

There are pertinent limitations regarding the generalizability of the findings. There were 785 students from the community college and 1646 students from the regional university that were invited to participate in the research (n = 2431). However, only 95 students (4% total; 31.6% from the community college and 68.4% from the university) actually completed the STEM survey. Of those that completed the survey, 61 were invited to participate in the focus-group interviews based on their response to the inquiry regarding their willingness to participate (at the conclusion of the STEM survey). Twenty students responded to the invitation and participated in the focus-group interviews. All students were contacted via their school email addresses. The Education Advisory Board (2020) states that in a survey of 315 students, 54% stated they do not routinely check emails from their university or academic departments.

Students cite that the volume of emails they receive is “too high,” which results in indifference (Education Advisory Board, 2020).

This study examined a small sample of students from one community college and university in a specific geographic region. There was an overrepresentation of females from both institutions (64 females and 31 males) among STEM participants. However, this is a trend that is representative of the Spring 2022 enrollment at the community college, which enrolled 69% female and 31% male (Dyersburg State Community College, 2022). Similarly, the university had an enrollment of 61.6% female and 38.4% male during the Fall 2021 semester (University of Tennessee at Martin, 2022).

Many postsecondary institutions have shrunk in enrollment since the onset of the COVID-19 pandemic, and more women have stopped attending than men (National Student Clearinghouse Research, 2022). The greatest decreases in enrollment have occurred among public 2-year colleges at -7.8%; enrollment among men decreased 5.6% in the 2022 spring semester, while enrollment among females fell by 9.2%. The trend is not as disparate among gender at the public 4-year schools (overall decrease in enrollment of 3.4%), with a decrease of 3.3% enrollment among males and an increase of 3.4% among females (National Student Clearinghouse Research Center, 2022).

This study was conducted at a community college and regional comprehensive university in an area with low SES. There was a lack of diversity among the participants in the study, with an overrepresentation of White and non-Hispanic (89.4%). Enrollment of White and non-Hispanic students was 72% at the community college (Dyersburg State Community College, 2022), and 78.6% at the university (University of Tennessee at Martin, 2022). Black or African American students were underrepresented in the study, comprising 8.5% of the survey respondents, however this is in accordance with previous research indicating that minority groups are frequently underrepresented in STEM fields (Crisp et al., 2009; Niu, 2007). Data from the National Student Clearinghouse Research Center (2022) indicates that college enrollment of Black or African American students is down by 6.5% as compared to 2021 enrollment estimates. The community college had an enrollment of 17.7% (Dyersburg State Community College, 2022) and the university had 12.3% (University of Tennessee at Martin, 2022) of minority groups in STEM majors.

While enrollment by gender may not be representative of other colleges and universities, there are also limitations that should be recognized in terms of representation by race and ethnicity. Thus, the findings of this study may be limited to the experiences of the students at these institutions. Additionally, interview responses may have been influenced by my presence in the focus group. I am a white middle-class female and respondents may have been apprehensive to fully share their personal experiences with me, as I may not have been considered someone whom they felt could be sympathetic to their economic situation (i.e., from low SES).

Another limitation is the duration of the study. Data was collected at only one point of time. A long-term study that follows participants to degree completion may have the potential to yield a clearer picture of the impact of socioeconomic status on students' perseverance in a STEM field. Further, the impact of the COVID-19 pandemic on SES and postsecondary attendance may have been insightful in identifying factors that impact identity, choice, and persistence.

Analyses

There were other measures that could have been investigated, including demographic and interview questions. Differences among gender, race and ethnicity, and class standing were not included in the regression analyses. There were also no measures on differences in STEM identity, choice, and persistence by institution. Including data for regression analyses may be instrumental in identifying other factors that interact with SES and students' perceptions of their STEM identity and perseverance. Further, disaggregating data by institution may yield clues as to how postsecondary institutions can better address the needs of their student body. This could be potentially more contributory at the 2-year colleges, as they are open-access and serve a broader range of students in terms of ability level and SES. The percentage of Pell eligible students at the community college was 57.4% (Dyersburg State Community College, 2022), compared to 43% at the regional university (University of Tennessee at Martin, 2022).

Recommendations for Future Research

Future research on the impact of SES on STEM identity, choice, and persistence should include a cohort study of STEM majors from the beginning of their college careers through degree completion. Following a cohort during their postsecondary education may yield a broader understanding of the factors that are determinant in shaping a student's perception of being a STEM professional (Estrada et al., 2016). Additionally, such a study could identify variables that may act in part to help a student choose a STEM-related major or the decision to change their major to a non-STEM field.

A multi-year study can yield a more comprehensive understanding of the factors that most strongly influence student persistence, and may create a clearer picture of the impacts of SES, especially in terms of food security status. Item 5A of the USDA Food Security Survey (Appendix B) asks participants how many days in the past 30 days that adult(s) did not eat because there was not enough money for food, to which one focus-group respondent stated:

> It almost makes me sad how many of these apply to my high school years. I think they all [survey questions] have in the past, but not recently.

STEM survey questions should also be modified to relate only to each specific STEM discipline for student respondents. The survey used in this study encompassed queries across STEM disciplines, and may not have been as effective in measuring STEM identity, choice, and persistence in comparison to a more targeted discipline-specific survey. Considerable attention should be devoted to how questions are asked to avoid bias (American Psychological Association Task Force on SES, 2007; Sweeney, 2015).

Additionally, many individuals are also reluctant to share information in a group setting, thus, structuring a follow-up interview with multiple options for participation may be helpful in recruiting a larger sample size of participants; options could include an interview that can be completed in a written format, one-on-one interviews (in person or virtual), by text, or an interactive smartphone app.

Regardless of the focus of further research, it is important to use discernment and avoid analyzing those who belong to the same SES group or racial and ethnic group under the same lens (Ramdial and Campbell, 2014). While relationships can be drawn between SES and factors affecting the development of STEM identity, choice, and persistence, it is important to heed the knowledge that these factors are not congruent across student groups and caution should be taken when generalizing.

Summary

The future of STEM is vital to maintain our country's competitiveness and to keep our infrastructure safe. Demand for STEM jobs is steadily increasing as new technologies become available to help us navigate and learn more about our world. While job demand is growing, so is the poverty rate (Shrider et al., 2021). As the poverty rate increases, inequity in education looms larger and the number of underserved students increases (Gaughan & Bozeman, 2015). A greater number of underserved students will likely increase the diversity gap among the STEM workforce. It is imperative for federal, state, and local agencies to collaborate with education and community leaders to identify the barriers that prevent students from identifying, choosing, and persisting in STEM. It is also of utmost importance to comprehend and understand that factors can change depending on region and culture. Such an interdisciplinary approach can break down the silos that hold us back, and encourage a collective approach at developing reasonable and sustainable practices that can inevitably produce diverse and qualified professionals capable of meeting the needs of an ever-changing world.

Appendix A

Murray State University IRB Approval Letter

MURRAY STATE
UNIVERSITY

Institutional Review Board

328 Wells Hall
Murray, KY 42071-3318
270-809-2916• msu.irb@murraystate.edu

TO: Jay Parrent, Educational Studies Leadership and Counseling

FROM: Jonathan Baskin, IRB Coordinator JB

DATE: 1/26/2022

RE: Human Subjects Protocol I.D. – IRB # 22-112

The IRB has completed its review of your student's Level 1 protocol entitled *The Impact of Socioeconomic Status on STEM Identitiy, Choice, and Persistence*. After review and consideration, the IRB has determined that the research, as described in the protocol form, will be conducted in compliance with Murray State University guidelines for the protection of human participants.

The forms and materials that have been approved for use in this research study are attached to the email containing this letter. These are the forms and materials that must be presented to the subjects. Use of any process or forms other than those approved by the IRB will be considered misconduct in research as stated in the MSU IRB Procedures and Guidelines section 20.3.

Your stated data collection period is from 1/26/2022 to 3/11/2022.

If data collection extends beyond this period, please submit an Amendment to an Approved Protocol form detailing the new data collection period and the reason for the change.

This Level 1 approval is valid until 1/25/2023.

If data collection and analysis extends beyond this date, the research project must be reviewed as a continuation project by the IRB prior to the end of the approval period, 1/25/2023. You must reapply for IRB approval by submitting a Project Update and Closure form (available at murraystate.edu/irb). You must allow ample time for IRB processing and decision prior to your expiration date, or your research must stop until such time that IRB approval is received. If the research project is completed by the end of the approval period, then a Project Update and Closure form must be submitted for IRB review so that your protocol may be closed. It is your responsibility to submit the appropriate paperwork in a timely manner.

The protocol is approved. You may begin data collection now.

Opportunity *afforded*

murraystate.edu

Appendix B

U.S. Adult Food Security Survey

Part 1: Questions asked of all households.

Directions: The following statements have been made by people about their food situation. For each statement, please indicate whether the state was **often** true, **sometimes** true, or **never** true for you and/or your household in the past month.

H1. I worried about whether my food would run out before I got the money to buy more.
- □ often true
- □ sometimes true
- □ never true
- □ don’t know

H2. The food that I bought just didn’t last, and I didn’t have money to get more.
- □ often true
- □ sometimes true
- □ never true
- □ don’t know

H3. I couldn’t afford to eat balanced meals.
- □ often true
- □ sometimes true
- □ never true
- □ don’t know

Directions: If you answered **often true** or **sometimes true** to one or more of the questions in part 1, please go on to part 2. Otherwise, skip to the end of the Adult Food Security Survey.

Part 2: Adult Stage Questions.

A1. In the last 30 days did you or anyone in your household ever cut the size of your meals or skip meals because there wasn’t enough money for food?
- □ Yes
- □ No
- □ don’t know

A1a. If yes to the last question, how many days did this happen?

_____ days

□ don’t know

A2. In the last 30 days, did you ever eat less than you felt you should because there wasn’t enough money for food?

□ Yes
□ No
□ don’t know

A3. In the last 30 days, were you ever hungry but didn’t eat because there wasn’t enough money for food?

□ Yes
□ No
□ don’t know

A4. In the last 30 days, did you lose weight because there wasn’t enough money for food?

□ Yes
□ No
□ don’t know

Directions: If you answered yes to one or more of questions 4-7, continue to Part 3. Otherwise, skip to the end of the Adult Food Security Survey.

Part 3: Adult Stage 3.

A5. In the last 30 days, did you or another adult in your household ever not eat for a whole day because there wasn’t enough money for food?

□ Yes
□ No
□ don’t know

A5a. If you answered yes, how many days did this happen in the last 30 days?

_____ days
□ don’t know

End of Adult Food Security Survey

Appendix C

STEM Survey

Item No.	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
S1	I can do well in my science classes.					
S2	I am able to complete assignments in my science classes.					
S3	I plan to use science in my future career.					
S4	I will work hard in my science classes.					
S5	Science will help me in my future career.					
S6	My professor thinks that I am good at science.					
S7	I enjoy discussing science topics with others.					
S8	I am knowledgeable about some science topics.					
S9	I understand the science I have studied in school.					
S10	I feel confident in my ability to learn science.					
S11	My friends and family think I am good at science.					
S12	I would like to have a science job in the future.					

Item No.	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
M1	I am able to do well in my math classes.					
M2	I am able to complete assignments in my math courses.					
M3	I plan to use math in my future career.					
M4	I work hard to do well in my math classes.					
M5	Math will help me in my future career.					
M6	Teachers I have had in the past think I am good at math.					
M7	I like talking to people about math.					
M8	I know a lot about some math-related topics.					
M9	I understand the math I have studied in school.					
M10	I feel confident in my ability to learn math.					
M11	My friends and family think I am good at math.					
M12	I would like to have a math-related job in the future.					
M13	I like to participate in activities or games that involve math.					
T1	I am able to learn new kinds of technologies.					

Item No.	Question	Strongly Disagree 1	Disagree 3	Neutral 3	Agree 4	Strongly Agree 5
T2	I plan to use technology in my future career.					
T3	I am willing to learn about new technologies that will help me in school.					
T4	Learning about new technologies will help my do lots of different types of jobs.					
T5	I am able to get better grades when I use technology at school.					
T6	I like to use technology for class work.					
T7	I am interested in careers that use technology.					
T8	I feel comfortable talking to people about using technology.					
T9	Teachers I have had in the past think I am good at using technology.					
T10	My friends and family think I am good at using technology.					
T11	I like to participate in activities that use technology.					
E1	I am able to do well in activities that involve engineering.					
E2	I plan to use engineering in my future career.					
E3	I will work hard on activities at school that involve engineering.					

Item No.	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
E4	If I learn a lot about engineering, I will be able to do lots of different types of careers.					
E5	My friends and family think I am good things that involve engineering.					
E6	My professor thinks I am good at things that involve engineering.					
E7	I like to participate in activities that involve engineering.					
E8	I feel confident in my ability to learn about engineering.					

Appendix D

Focus Group Interview Protocol

Introduction by Principal Investigator.

- Good evening and welcome. I am the Principal Investigator and I will be moderating this focus group session. I am currently an assistant professor of biology at Dyersburg State Community College and am collecting research data for my doctoral degree at Murray State University. My thesis is entitled *The Impact of Socioeconomic status on STEM Identity, Choice, and Perseverance.*
- We are going to be talking about your experience(s) in either a science, technology, engineering, or math related educational journey. This will help me the researcher understand the factors that have been most helpful or has been a barrier for you in STEM.
- This focus group is part of a varied approach to learn more about the factors that encourage or discourage a student from choosing to major in a STEM field and ultimately completing a degree in that field.
- Everyone will have an opportunity to speak, but I do ask that only one person speak at a time.
- Please feel free to use the chat option if you do not feel comfortable speaking up.
- The results of the focus group will be summarized and you will receive an email summary in two weeks. If you perceive that any key points were omitted or misconstrued, please feel free to let me know.
- This meeting will be recorded for the purpose of transcribing individual stories and identifying patterns or themes, and will not be shared with anyone.
- I am now going to read the recorded media consent.

- I agree to be video and audio recorded as part of my participation in the study, "*The Impact of Socioeconomic Status on STEM Identity, Choice, and Perseverance*" conducted by the Principal Investigator. I understand that I do not have to agree to be recorded in order to participate in this study and that I may decide to withdraw at any time. I also understand that the video and audio recording will be kept in a secure place and destroyed at the completion of the research project.
- I understand that this form expires one year from the date I sign it, and that any further video and audio recording beyond that date would require my voluntary consent. By signing below, I am agreeing and granting permission for me to be video and audio recorded for this study. I understand that my confidentially will be maintained as outlined in the informed consent.

- I am now going to put the link to agree to the consent to record in the chat. Please click on that link and click yes if you agree to being recorded: https://forms.gle/dRDSZcSBWgk5DGfh9

Appendix E

STEM Experiences Questions for Focus Groups

1. What year are you in school (freshman, sophomore, junior, senior, or graduate)?
2. What is your major and what do you hope to do with that degree in the future?
3. What made you be able to see yourself as a professional in a science, technology, engineering, or math field?
4. How do you want to make a difference in the world?
5. Can you tell me about your best experience in a math or science class?
6. Can you tell me how that made you feel?
7. What about your worst experience in a math or science class?
8. Who has been the most influential person in igniting your interest and how?
9. How has your socioeconomic status impacted your educational journey?
10. Does your household depend on you to work for financial support, and how has that impacted your educational career? If that were different (improved), how do you think it would impact your STEM journey?
11. How can resources at your school help you with planning your educational journey to a STEM career?
12. What has been your biggest barrier in STEM education, and how have you overcome it?
13. Is there something you would like to discuss that wasn’t brought up in this interview?

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