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The Influence of College among Undergraduate Science, Technology, Engineering, and

Mathematics (STEM) Majors on Career-Decision-Making Self-Efficacy

by

George Ahmad Goff IV

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Doctor of Philosophy Degree

Higher Education

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An Abstract of

The Influence of College among Undergraduate Science, Technology, Engineering, and

Mathematics (STEM) Majors on Career-Decision-Making Self-Efficacy

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George A. Goff

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the
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This study explored the career decision-making self-efficacy among undergraduate

Science, Technology, Engineering, and Mathematics (STEM) majors. Students from

three organizations, Louis Stokes Minority Alliance, National Black Chemist and

Chemical Engineers, and Charles Drew Scholars, participated in the study to determine

factors influencing their decisions to pursue STEM majors. A total of 187 undergraduate

students completed an electronic questionnaire developed for the study. Data were

analyzed using Astin's I-E-O Model. The results of the stepwise multiple linear

regression analysis provided support that nine variables, age, number of advanced

placement courses, membership in professional STEM organizations, highest academic

goal, number of hours/days spent studying in college, it is my passion, want to make a

difference, encouraged by teacher/ guidance counselor, and socialize with other students,

were significant predictors of career decision-making self-efficacy. The results provided

support that Astin's input, environment, and output model of college retention was

relevant for these students. Further research is needed to find ways to increase the

number of students who are pursuing majors to prepare for STEM-related careers.

I would like to dedicate my dissertation to the "rare gems" in making me the man I am today: my maternal great-grandparents, Mr. Jimmie Clay and Mrs. Archie Mae Hill Clay; paternal great-grandparents, Mr. George Goff and Mrs. Bertha Willis. My maternal grandmother, Mrs. Beatrice Hill Amerson and my paternal grandparents: Mr. George Goff II and Jennie Mae Goff and Sara Mae Stephens-Goff-Perry and Mr. Ollie Perry. My loving and supportive parents, Mr. George Goff III and Mrs. Sara Clay Goff. My extended Stepparents, Ms. Jackie Mathis and Mr. Andre Micheaux, My God Parents, Mr. Rudy Poindexter, Mrs. Gloria Poindexter, Mr. James Jim Sharp, and Mrs. Tessie Sharp. My wonderful Godmothers Mrs. Edwina McCall, Mrs. Carol Carter, Mrs., Annette Sharp Schley, Ms. Glennette Sharp, Mrs. Jessie Jefferson and Mrs. Lucinda Goode-Tyus and my God siblings, Mrs. Simone Bright, Mr. Alonzo Bright, Mr. Cornell Mathis and Mrs. Cashawnda Range Mathis and Mr. Rudy Poindexter II.

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Table of Contents

List of Tables

xi

List of Figures

Chapter One

Introduction

Background of the Study

This chapter presents an overview of the study, including the research problem statement, the purpose of the study, the conceptual framework, and the research questions. The purpose of this study was to determine factors influencing undergraduate students who were members of National Organization of Black Chemists and Chemical Engineers (NOBCChE), Charles Drew Science Scholars Program (CDSSP), and Michigan Lewis Stokes Alliance for Minority Participation (MI-LSAMP) to select majors in science, technology, engineering, and mathematics (STEM) and pursue careers in STEM areas.

Science, technology, engineering, and mathematics (STEM). The United States faces a political and social crisis because of a lack of students, teachers, and practitioners entering science, technology, engineering, and mathematics (STEM) fields. STEM careers involve planning, managing, and delivering scientific research. This includes professional and technical services (physical science, social science, and engineering). STEM careers also include laboratory and testing services as well as research and development services (O*Net Online, n.d.). Individuals majoring in STEM programs can become engineers, chemists, biologists, botanists, mathematicians, physicists, statisticians, epidemiologists, college instructors and professors, elementary and secondary science teachers, software developers, geneticists, among other choices.

During their course of study, STEM professionals need to complete an undergraduate or graduate course of study stressing science and mathematics. College

programs requiring courses in science and mathematics can either motivate or discourage students to pursue careers in STEM-related disciplines, depending on students' comfort level and skill in these subjects.

National Shortage of STEM workers. Workers in science, technology, engineering, and mathematics (STEM) careers continue to be important to American innovation and competitiveness in an increasingly dynamic and global marketplace. Information from the United States Census Bureau (2011) showed (a) keeping a vital STEM workforce is important to the United States economy and (b) the United States needs technology workers trained in science, technology, engineering, and mathematics. The competitive edge in the global market enjoyed by the United States in the past has been eroding steadily during the past decade as low-wage workers around the world are completing highly-skilled tasks (Smith, 2010) generally performed by individuals in STEM careers.

Reports from prominent national societies and commissions calls for new policies and initiatives aimed at expanding the nation's scientific, engineering, and technical workforce. These reports raised concerns about America's ability to keep competitive positions in the global economy renewing interest in STEM education. The National Academy of Science (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine jointly issued a report in 2005 entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* This report called for strengthening the STEM pipeline from primary educational levels through postsecondary educational levels (NAS, 2007). This report recommended increasing investments in STEM programs, improving the STEM teaching force, and increasing

2

students pursuing degrees and careers in STEM fields. Federal and state legislative efforts targeted improving STEM education in mathematics, natural sciences, engineering, and technologies (Kuenzi, Matthews, & Mangan, 2006; National Governors Association, 2007). To transition successfully from college to a technologically advanced professional environment, students need to be academically prepared in math and science (Bush, 2006; Flowers, Milner, & Moore, 2003; Maton, Hrabowski, & Schmitt, 2000).

National shortage of STEM students. According to Byars-Winston, Estrada, and Howard (2008), "in 2004, China and India produced 500,000 and 200,000 engineers . . . while U. S. colleges graduated 70,000" (para. 1). In 2004, the United States ranked 20th of 24 countries with degrees earned in the natural science and engineering fields (Kuenzi, 2008). The top five countries were Finland, France, Taiwan, South Korea, and the United Kingdom (Kuenzi, 2008). Table 1 provides the change in the number of bachelor's degrees conferred by colleges and universities in the United States between 2000 and 2009. While some growth has occurred in the number of STEM graduates from 2000 to 2009, the greatest growth has been in the social sciences.

Two primary reasons exist for the comparatively low STEM undergraduate degrees in the United States. The two reasons are: declining student interest because of a lack of exposure among minority students to STEM fields early in their academic career (Kuenzi, 2008) and the underrepresentation of bachelor degrees earned by targeted minority students (African Americans, Latinos, Southeast Asians, and Native Americans [ALANA]) when compared to degree completion by Caucasians in all science and engineering fields (Byars-Winston et al., 2008). According to Byars-Winston et al.

3

Table 1

STEM Bachelor's Degrees by Fields, 2000-2009 (In Thousands)

Year	Social/ behavioral sciences	Biological/ Agricultural Sciences	Engineering	Computer Sciences	Physical Sciences	Mathematics
2000	188.15	83.13	59.49	37.52	18.60	11.71
2001	188.60	79.48	59.21	43.60	18.11	11.44
2002	196.40	79.03	60.61	49.71	17.98	12.25
2003	208.90	81.22	63.79	57.93	18.06	12.86
2004	220.35	81.81	64.68	59.97	18.12	13.74
2005	230.60	85.09	66.15	54.59	18.96	14.82
2006	236.67	90.28	68.23	48.00	20.38	15.31
2007	241.22	97.04	68.27	42.60	21.08	15.55
2008	248.66	100.87	69.91	38.92	21.97	15.84
2009	252.92	104.73	70.60	38.50	22.48	16.21

Source National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science foundation, National Center for Science and Engineering Statistics, WebCASPAR database (2012).

(2008), freshman ALANA and European American students had similar goals about pursuing STEM-related majors. Fewer ALANA majored in STEM fields, and those who declared a STEM major, a greater percentage dropped out before completing their degrees (Byars-Winston et al., 2008).

The dropout rates for college students of color (Native Americans, Hispanics, and African Americans) majoring in STEM disciplines are higher than for either Caucasians or Asians students (White, 2005). About 50% of African American and Native American students who declare a major in a STEM-related discipline are more likely to drop out or switch majors (White, 2005). More than 60% of Hispanic students majoring in a STEM discipline drop out of college before completing their degrees (White, 2005). Students of color (African American, Hispanic, and Native American) nationwide received 12% of

4

degrees in STEM-related disciplines in 1998 (White, 2005). White, Yelamarthi and Mawasha (2008) reported 12.6% of all bachelor-level professional degrees in 2001 were earned by underrepresented minorities. The percentage of bachelor's degrees awarded in science and engineering (15.7%) were to underrepresented minorities in 2007.

Besides these factors, other national statistics showed a low number of graduates among students of color in STEM majors. Among those earning a bachelor's degree in STEM disciplines, statistics showed African Americans make up 2.7%, Native Americans and Alaska Natives make up 3.3%, and Hispanics and Latinos make up 2.2% (National Science Board [NSB], 2008). Because of the disproportionate number of African American students earning advanced degrees in STEM fields. This same statistical disproportion found in African Americans in STEM careers. According to the United States Census Bureau's (2011) American Community Survey (ACS), non-Hispanic Whites hold almost three of four STEM jobs (72%). NonHispanic Asians make up 14% of all STEM workers but only 5% of the United States workforce (United States Census Bureau, 2011). NonHispanic Blacks and Hispanics each accounted for only 6% of all STEM workers (United States Census Bureau, 2011).

About 25% of students who earned bachelor's degrees in 2010 had majored in STEM-related disciplines (National Center for Education Statistics [NCES], 2012.) Table 2 presents the percentage of students of different ethnic groups by gender who earned bachelor's degrees in STEM majors.

5

Table 2

Percentage of Students Completing Bachelor Degrees in STEM Major by Ethnicity and Gender (Year 2010)

	Percentage of Bachelor's Degrees in STEM Majors		
Ethnicity	Male	Female	Total*
Asian and Pacific Islanders	40	33	36
Caucasian	27	23	25
American Indian or Alaskan Natives	27	21	23
African-American	22	20	21
Hispanic	24	17	20
Total	28	22	25

National Center for Education Statistics [NCES], 2012, p. 207
*Percent of each ethnic group that was awarded bachelor's degrees in STEM fields

Although the number of African Americans entering and persisting in STEM careers has been disproportionate when compared to Asians and Caucasians, minorities and women have been entering male-dominated careers in increasing numbers in the past 10 years (National Science Foundation, 2012). Results from many researchers, who have studied the characteristics of women who engage in nontraditional careers (Huang, Taddese, Walter & Peng, 2000; Mau, Domnick, & Ellsworth, 1995), reached this conclusion.

According to Moore (2010), research suggest minority students have been overlooked as a resource holding promise for developing a stronger STEM workforce:

> Many social scientists and economists have argued the U.S. desperately needs to attract nontraditional students, such as African-American males, into technical and advanced coursework (science, technology, engineering, and mathematics) at all phases of their education to meet the need for a highly skilled workforce (p. 2).

6

Former President George Bush (2006), in his State of the Union address, encouraged members of the United States educational system to begin training teachers to promote interest in STEM careers among students:

> …we need to encourage children to take more math and science and to make sure those courses are rigorous enough to compete with other nations. I propose to train 70,000 high school teachers to lead advanced placement courses in math and science, bring 30,000 math and science professionals to teach in classrooms, and give early help to students who struggle with math so they have a better chance at good, high-wage jobs. (para. 101-102)

National shortage of African-American STEM students. African Americans earned STEM degrees at decreasing levels compared to recent decades (National Science Board [NSB], 2008). According to an NSB (2008) report, African Americans make up 12% of the United States population. African Americans in 2009 received just 7% of all STEM bachelor's degrees, 4% of STEM master's degrees, and 2% of STEM doctoral degrees in the United States (NSB, 2006). The NSB (2008) reported African Americans received only 4% of degrees in mathematics and statistics and just 1% of degrees in science technologies. Doctoral degrees were awarded to 5,048 students in the physical sciences (chemistry and physics) and 89 were awarded to African Americans representing less than 2%. According to an NSB report entitled *Science and Engineering Indicators 2006* (2008), 34% of African American freshman intended to major in STEM fields. The NSB (2006) reported African Americans made up 13.3% of freshmen starting college in 2001, but African Americans received 9% of the bachelor's degrees granted four years later. Of the 9% who received bachelor's degrees, roughly 8.8% of these graduates majored in STEM fields (NSB, 2006). These statistics reinforce a lack of minorities seeking majors in STEM fields.

7

In the fall 2007, 119,330 (38.5%) African American male students enrolled at HBCUs (National Science Board, 2007). In comparison, 190,270 (61.5%) African American female students attended HBCUs during the same time period (NSB, 2007). The Quality Education for Minorities (QEM) Network (2010) reported African American females in 2007 earned 67.9% of bachelor's degrees awarded by HBCUs in STEM fields, while African American males earned only 32.1 % of the STEM degrees. Hurtado, Eagan, Pryor, Whang, and Tran (2012) reported European and Asian American students in 2010 who started as STEM majors had four-year STEM degree completion rates of 24.5% and 32.4%, respectively. Hispanic American, African American, and Native American students who first began college in STEM majors experienced four-year STEM degree completion rates of 15.9%, 13.2%, and 14%, respectively. Males at HBCUs made up nearly 60% of all STEM majors, although females earned a greater number of degrees in STEM fields (NSB, 2008). These statistics suggest gender differences are prevalent in STEM majors and in STEM occupations.

Gender differences in STEM majors.

African American females in 1998 accounted for 9.7% of the bachelor's degrees awarded to females in science and engineering. African American males earned 5.7% of the bachelor degrees in science and engineering awarded to all males (Hill, 2001). African-American males' perceptions of how educators perceive them have profound effects on their educational goals (Flowers, Milner, & Moore, 2003; Henfield, Moore, & Wood, 2008; Moore, 2006; Moore, Madison-Colmore & Smith, 2003).

Studies examining differences in academic achievement between females and males have increased in recent years. These studies have shown gender influences

educational outcomes (Flowers, Osterlind, Pascaerella & Pierson, 2001). National data showed differences between females and males enrolled in STEM majors (Burrelli, 2008). Mau (2003) found academic proficiency, math self-efficacy, being male, and being African American were statistically significant predictors of persistence. The important result of Mau's study was academic achievement and self-efficacy were important factors in persisting students in science and engineering careers.

Factors influencing persistence among African-Americans pursuing STEM majors.

Factors including (a) a commitment to engineering, (b) familial support, (c) integration into the social and academic environment, (d) connection with or a link to academic resources, (e) clear goals with a practical plan of action, (f) regular interaction with African American and nonAfrican American peers, and (g) a sense of racial identity, influence African Americans' pursuit of degrees in STEM majors. The factors are summarized in Table 3.

Moore (2000) studied the decisions of African Americans to persist in college and pursue engineering as a career. Moore's (2000) study found specific factors influenced the decisions African American men made to persist and earn a bachelor's degree in engineering. If the factors influencing retention and persistence in STEM majors are absent, African American males might be less likely to complete a degree in engineering and more likely to change majors or drop out of college.

Berryman (1983) and Oakes (1990) identified the need for students to gain exposure and access to science and mathematics experiences both in school and out of school to enter mathematics and science careers successfully. According to Stanton-

9

Salazar (2004), "Student variations in academic learning, intellectual development, and persistence to degree completion [are] dependent on a student's personal engagement or social integration into the social and intellectual fabric of the school" (p. 13). When addressing how participants perceived the relationships between interpersonal networks, social capital, and their impact of these forces on STEM choices, African American students in this study identified key individuals and explained the interconnectedness and interrelatedness of individuals within fictive kin-supportive networks and opportunities for dialog support. This dialogue allowed the transmitting information, resources, and opportunities necessary for making STEM choices and decisions. Table 2 presents themes emerged from the comprehensive review of literature on STEM majors.

Wehlage, Rutter, Smith, Lesko, and Fernandez (1989) explored integrative processes in schools serving low-income students. Their research focused on school memberships and examining of students' connections to the social and intellectual fabric of schools. Students were connected to the social and intellectual fabric of their schools through the bonds they developed with school personnel (Wehlage et al., 1989). Wehlage et al. (1989) suggested students must think they belong to the school community to lessen feelings of alienation with their teachers and peers. According to social integrationists, students must become integrated with the different social life in their institutions (Maldonado, Rhoads & Buenavista, 2005).

Statement of the Problem

To meet the growing demand for a highly qualified scientific and technical workforce in the future, this study is important because it can help secondary and college administrators understand positive and negative factors influencing recruitment and

10

retention efforts among college students majoring in STEM and pursue a STEM related career. The present research identified nine variables (age, father has a bachelor degree, annual family income, advanced placement courses in STEM, current cumulative college GPA, it is my passion, country needs college graduates in STEM, discussed ideas from readings with STEM instructors, and discussed career plans with instructor) were significant predictors of career decision-making self-efficacy. All predictors, except father has a bachelor's degree, were in a positive direction. This present study can fill the gap from prior research by identifying and explaining how the nine variables can influence career decision-making self-efficacy for undergraduate science, technology, engineering, and mathematics (STEM) majors. Prior and current studies in the literature did not address factors influencing undergraduate students to pursue STEM-related majors. Additional research is needed to examine ways to increase students graduating from high school with suitable mathematics and science preparation to pursue STEM or STEM-related college majors. Few research studies focused on themes influencing college students to pursue STEM careers, and African Americans are underrepresented among graduates earning STEM degrees, when compared to their male and female nonAfrican American counterparts (Moore, Madison-Colomore & Smith, 2003). The reasons for these discrepancies have not been the focus of earlier research. A study is needed focusing on understanding factors influencing undergraduate college students to pursue STEM majors.

Purpose of the Study

The purpose of this study was to determine which factors (personal

characteristics, family characteristics, self-appraisal, occupational information, goal

selection, planning, and problem solving) influencing college students to major in STEM

Table 3

Themes Associated with STEM Majors

Author	Theme 1 Pre-Characteristics	Theme 2 Mentoring/Faulty Involvement	Theme 3 Self-Efficacy /Personal	Theme 4 Family/Social Support
Bandura (1977, 1994, 2012)			Self-efficacy, social learning theory	
Berryman (1983); Oakes (1990)	Exposure and access to science and mathematics experiences in and out school			
Billingsly (1992); Hill (2001)			Capacity to persevere during challenging times.	
Hall (2003)	High expectations.		.	Consistent communication, advocacy, skills and knowledge, reinforcement, and encouragement for social integration and success.
Lent, R., Brown, S., & Hackett, G. (1994).			Career self-efficacy	
Moore (2000)	Pre-engineering			
Stanton-Salazar (2004)		Multiple webs of committed and caring institutional agents.	Personal engagement.	Social freeways to privilege and power.
Taylor & Betz (1983)			Career decision-making self-efficacy	
Wehlage, Rutter, Smith, Lesko, &				Socioeconomic status

12

Author	Theme 1 Pre-Characteristics	Theme 2 Mentoring/Faulty Involvement	Theme 3 Self-Efficacy /Personal	Theme 4 Family/Social Support
Fernandez (1989)				School memberships Students' connections to the social and intellectual fabric of schools

Note: Table developed by the researcher to combine research on themes emerging from the literature that have influenced persistence of undergraduate students in pursuing STEM careers.

disciplines. Identifying factors having influenced college students' decisions to pursue STEM majors as their career choices is important to increase the number of people pursuing careers in science, technology, engineering, and mathematics.

Research Questions

The following research questions guided this study:

RQ1. What influence, if any, do student demographic characteristics have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ2. What influence, if any, do major choice variables, have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ3. What influence, if any, do student-to-student interactions have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ4. What influence, if any, do faculty-to-student interactions have on career-decision-making self-efficacy?

RQ5: What influence, if any, do high school variables have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ6: What influence, if any, do college variables have on career-decision-making self-efficacy among undergraduate STEM majors?

Significance of the Study

This quantitative study explored factors influencing college students to major in STEM disciplines. The results of this study could provide information for school administrators, teachers, counselors, and parents who interact with college students to encourage students to pursue STEM college majors. Because technology and science has become more important in the global economy, the need for scientists, engineers, and technology experts has increased. Understanding this need could influence college students to choose majors in STEM related fields. Students who commute may not be as involved in their campus life as students who lived on campus in the 1970s. Involvement may reflect commitment, which may relate to their decisions to persist at their present institutions.

College administrators are responsible for developing enrollment strategies to improve student recruitment and retention. Understanding factors contributing students' decisions to remain in college can provide a basis for these strategies. According to Astin (1984), faculty involvement with students is important in keeping students enrolled. Some faculty members may have to change their instructional methods to include one-on-one involvement with students. Students who commute to campus may become involved with activities on campus increasing their involvement.

Theoretical Framework

Theories on postsecondary student attrition, retention, and persistence were published in the 1970s and 1980s. These theoretical models provide an explanation for

14

behaviors associated with student attrition and persistence (Tinto, 1975, 1993, 1997). Theorists have studied attrition and retention from different perspectives. Tinto (1975, 1993, and 1997) studied sociological factors, while Astin (1984) focused on behavioral models. These theorists studied the influence of personal, family, and institutional characteristics (family background, socioeconomic status, organizational climate, and instructional climate) on attrition and persistence to explain why retaining some students while others leave before completing their programs.

Theorists and practitioners (Braxton, Milem & Sullivan, 2000) referenced Tinto's interactionalist theory of voluntary student departure. Tinto (1975) built on other theories including Durkheim's theory of suicide. Tinto's theoretical model supported student dropout from postsecondary institutions. Durkheim (as cited in Tinto, 1975) claimed individuals who had difficulty becoming +integrated in society were at risk for suicide than people who had become successfully integrated. Tinto applied certain aspects of Durkheim's theory to student attrition from colleges and universities, suggesting students who were more integrated into the institutional culture were more likely to continue. According to Tinto (1975):

> . . . the process of dropout from college can be viewed as a longitudinal process of interactions between the individual and the academic and social systems of the college during which a person's experiences in those systems (as measured by his normative and structural integration) continually modify his goal and institutional commitments in ways which lead to persistence or to varying forms of dropout. (p. 94)

Tinto stated personal characteristics, individual attributes, and prior experiences were important influences on expectations and commitments to college. In considering these factors, Tinto (1975) suggested:

. . . it is the individual's integration into the academic and social systems of the college that most directly relates to his continuance in that college. As the student becomes more integrated into the academic and social systems, the greater their commitment to the institution and the goal of degree completion. (p. 96)

Tinto (1975) stated added to students' academic or social integration into the culture of their institutions, other unrelated, external influences could also impact their commitment to their institutions and completing their degree needs.

Building on Tinto's theory, Astin (1984) developed the student involvement theory to help higher education administrators create and design environments conducive to learning. His theory is widely used in student attrition and persistence research "Quite simply, student involvement refers to the amount of physical and psychological energy that the student devotes to the academic experience" (p. 297). The behavioral aspects of "involvement" (the model stressed what the individual did and not what he or she thought or felt).

Conceptual Model

Astin (1984) researched college students in various ways. In his theory of student involvement, Astin explored college student engagement on college campuses. Many types of involvement theories have proposed determining college student's influence and success in their educational process.

The study applied Astin's (1991) input-environment-outcome (I-E-O) model. The I-E-O model reflects the relationship between inputs variables and environmental variables to evaluate their influence on possible outcomes (Astin, 1993). Astin explained when using the I-E-O Model, "outputs must always be evaluated in terms of inputs (Astin, 2001, p.17). Input variables such as ACT or SAT scores may influence or predict

outcome performance measures. If these inputs variables are not controlled, the analysis

of the influence of the college environment on the outcome performance measure may be

biased. Figure 1 presents Astin's I-E-O Model.

Astin's (1991) I-E-O model supports for the need to understand student

characteristics at the time students enter an educational institution, the environment in

which they interact, and the characteristics they have on exiting the institution. In

applying this model to the present study, the following variables measure three parts of

Astin's I-E-O model:
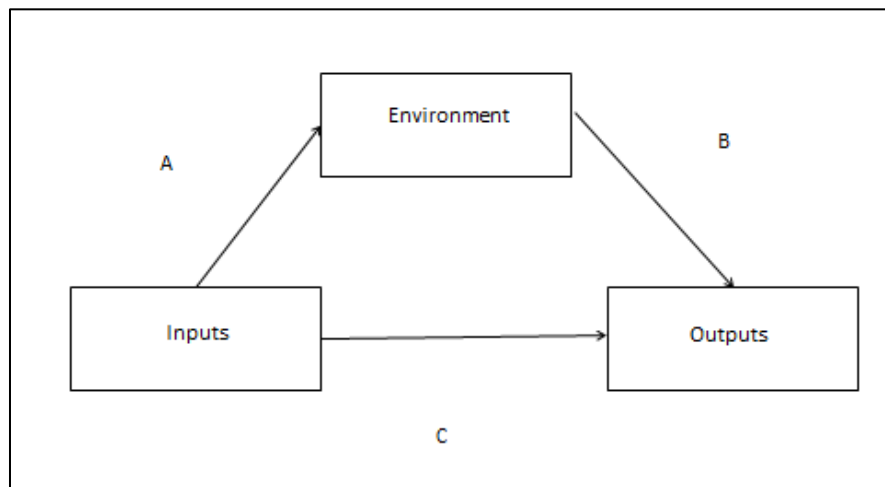
Figure 1: Astin's I-E-O Conceptual Model (Astin, 1991. *Assessment for Excellence: The Philosophy and Practice of Assessment and Evaluation in Higher Education*.)

Input Variables – personal characteristics, family characteristics, and choice

variables.

Environmental Variables – Student-to-faculty interactions, student –to- student

interactions

Output Variables – STEM self-efficacy.

17

Figure 2 presents the conceptual model for this study building on the IEO model to understand student characteristics at the time students enter an educational institution, the environment with which they interact, and the characteristics they have on exiting the institution.

Methodology

A quantitative research design using an online survey comprised of four sections for data collection helped determine if STEM self-efficacy could be predicted from personal and family characteristics, choice variables, student-to-student interactions, and faculty-to-student interactions. The participants in this study were student members of the National Organization of Black Chemists and Chemical Engineers (NOBCChE). A composite survey included four sections in the study: (a) a demographic survey for getting personal and educational information; (b) a Career Decision Self-Efficacy scale
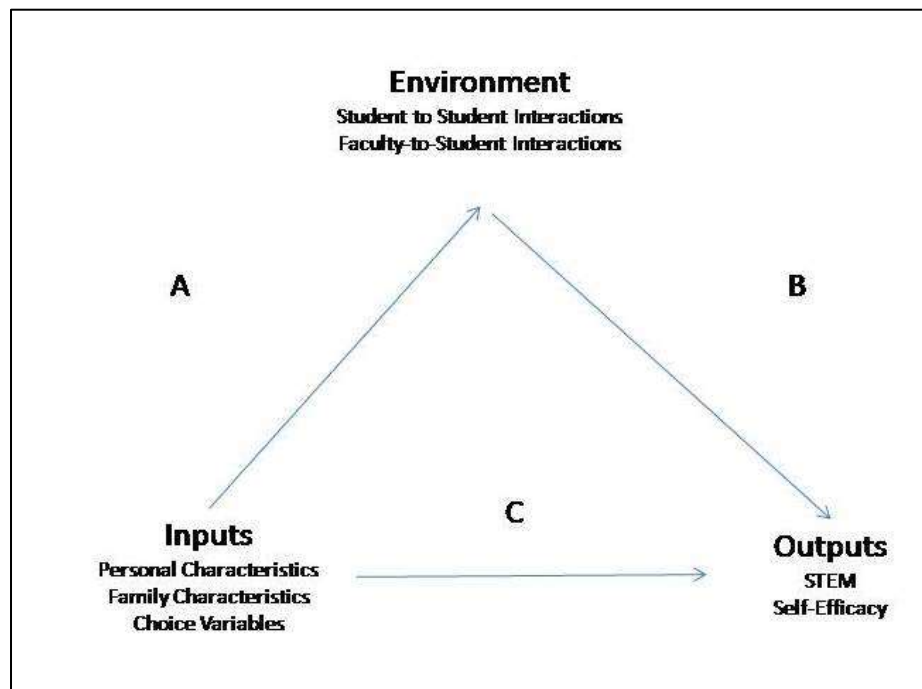
Figure 2: Conceptual Model for the Study

(Betz & Taylor, 2012) to measure students' self-efficacy in making STEM related career decisions; (c) a survey to obtain information on why students choose STEM majors adapted by the researcher from a Microsoft-Harris Poll study (2011), and (d) a survey developed by Campbell (2012) to measure student-to-student interactions and faculty-to-student interactions. Items on the survey measured three factors influencing selecting STEM as a major: input variables, environmental variables, and output variables. The data from the participants was collected and analyzed using multiple regression analyses to determine what influence, if any, these variables have on college students' decision to pursue STEM majors as well as their decision to choose STEM careers.

Limitations

Limitations are factors in a study not controlled by the researcher (Lunenburg & Irby, 2008). These factors may influence the interpretation of results and the generalizability of the results beyond the sample being studied. The researcher cannot be aware of all factors influencing individuals choosing a college or selecting a major. The study is limited to factors considered in previous literature. The study was limited to student members of three professional organizations (NOBCChE, CDSSP, and MI-LSAMP). Although the findings cannot be generalized beyond students who are members of these organizations and students majoring in STEM disciplines, the findings may be interesting to administrators in colleges and universities and other STEM-related organizations with student members.

Delimitations

Delimitations provide the boundaries for the study (Lunenburg & Irby (2008). Creswell (2003) defines delimitations as the constraints a researcher places on their study

19

to narrow its scope. This dissertation uses a quantitative approach to data analysis. The following delimitations are provided to narrow the scope of the study. The study is delimited to one national professional organization. A second delimitation is the participants included in the study are college students with a declared major in a STEM discipline. The study is delimited to four research questions providing comprehensive information about factors motivating students to purse STEM-related disciplines in college.

Assumptions

The foundation of every study necessarily reflects various logistical, procedural, conceptual, and methodological assumptions. The assumptions underlying this study include the following:

- The participants, who selected a major, decided the occupations they want to pursue following graduation.
- The participants were honest in answering items on the questionnaire.
- Reasons for persistence are similar across all programs and majors.
- Involvement theory applies to students in all programs and majors.
- While Tinto and Astin developed their theories in the 1970s and 1980s, their ideas remain valid.

Definition of Terms

Career Decision-Making Self-efficacy. Taylor and Betz (1983) described career-decision self-efficacy as the belief individuals had in their ability to accomplish behaviors and tasks associated with making career decisions.

20

Mentoring. An intensive, one-to-one form of teaching in which the wise and experienced mentor inducts the aspiring protégé into a particular, usually professional, way of life (Zimpher, N. L., & Rieger, S. R., 1988).

Self-efficacy. A person's estimate or personal judgment of his or her own ability to succeed in reaching a specific goal (Bandura, 1994).

STEM. The acronym STEM as defined by The United States Department of Commerce, Economics and Statistics Administration (ESA) refers to science, technology, engineering, and mathematics. The National Center for Education Statistics (NCES, 2012) defined STEM fields as mathematics and natural sciences (including physical sciences and biological and agricultural sciences); engineering and engineering technologies; and computer and information sciences. No standard definition has been developed to suggest what makes up a STEM career (NCES, 2012).

Summary

Statistics show there has been a decline in STEM degrees conferred in the United States among minority students. This decline is problematic because the expertise of individuals pursuing STEM careers is essential for preserving the continued success of American innovation and competitiveness, as well as for supporting growth in the overall national economy. To address this issue, national societies and commissions have recommended new policies nationwide to promote STEM career choices, beginning at the primary school level and continuing through college, increasing the STEM workforce. This study fills the gap by using Bandura's (1977) self-efficacy and Astin's Theory of Student Involvement (1984) and associated I-E-O model (1991) as frameworks to examine systematically what factors, if any, in the professional organizations

21

environment influence the development of student member's career decision making self-efficacy.

This chapter presented the problem addressed in this study, background information about STEM education, the purpose of the study, the research questions, and the significance of the study, the theoretical framework, the conceptual model, methods, limitations and delimitations of the study, assumptions, and definition of terms. Chapter 2 provides a comprehensive view of the literature on STEM education and factors influencing college students to pursue majors in STEM-related fields.

Organization of the Remaining Chapters

This dissertation has five chapters, including this one. Chapter 1 introduced the problem of research on the factors influencing college students majoring in STEM career decision making self-efficacy. Chapter 2 discusses the relevant literature on factors influencing college students. Chapter 3 presents the research methods including a discussion of the career decision making self-efficacy instrument, data collection procedures, and data limitations. Chapter 4 contains the study results and a presentation of data. Chapter 5 summaries the dissertation, results, and gives recommendations for further study and how the results can help college administers to design and preserve retaining incoming college students majoring in STEM.

<center>**Chapter Two**</center>

<center>**Review of the Literature**</center>

Introduction

This chapter provides a detailed synthesis of the literature relevant to this dissertation. Other major topics in this literature focus on exploring predictor variables to influence STEM Self-Efficacy. The first section in this chapter reviews Astin's (1984) involvement theory in higher education. This theory suggests encouraging students to become actively involved in their education would lead to success. Astin's (1991) Input-Environment-Output (I-E-O) model provides the conceptual framework for this national study exploring the influence of student-to-student interaction and faculty-to-student interactions on (a) career choice self-efficacy and (b) academic self-efficacy in choosing a major in a college environment. The second section in this chapter is discusses issues facing STEM-related disciplines. The concerns both of employers and college administers have led to considering many possible changes in policies effecting STEM education. Many research studies conducted help to identify variables influencing college students to achieve success, but there continues to be a gap in the literature about career choice and academic self-efficacy among college students choosing to major in STEM-related disciplines.

Self-efficacy theory.

One the most theoretically and practically useful concepts formulated in the literature has been Bandura's (1977, 1994, 1997, 2012) concept of self-efficacy expectations. Bandura's (1986) formations of self-efficacy theory included suggesting increases in self-efficacy expectations relative to one domain should generalize to some degree to other

<center>23</center>

domains. From this statement, statistically significant relationships among domain-specific measures of self-efficacy would be suggested. Scores on the Career Decision Self-Efficacy have been found to be moderately related to other measures of self-efficacy. In studies by Bandura (1986) and Lent, Brown, and Hackett (1994, 2000) social cognitive model of career behavior, efficacy expectations also suggest related expected outcomes.

Self-efficacy expectations, personal beliefs in an individual's capabilities to perform a given behaviors or class of behaviors successfully are postulated to influence behavioral choice, performance, and persistence. The concept of self-efficacy is widely studied by researchers, including Bandura (1997); Betz & Taylor (2012); Betz & Hackett (1981). Self-efficacy theory is viewed as one approach to studying and applying social learning or social cognitive theory (Krumboltz, Mitchell, & Jones, 1976; Lent, Brown, & Hackett, 1994, 2000). Bandura (1997) provided four sources of information influencing self-efficacy levels. These four sources are: (a) performances accomplishments, which is, experiences of successfully performing the behaviors in questions; (b) vicarious learning or modeling; (c) verbal persuasion, for example, encouragement and support from others, and (d) emotional arousal, which is, anxiety, in connection with behavior (Betz & Taylor, 2012). Low self-efficacy expectations regarding a behavior or behavioral domain lead to avoidance of those behaviors (Betz & Taylor, 2012). Betz and Taylor (2012) asserted increases in self-efficacy expectations should result in the frequency of approach versus avoidance behavior.

The Career Decision Self-Efficacy Scale.

Taylor and Betz (1983) developed the Career Decision-Self-Efficacy Scale measuring an individual's degree of belief he or she can successfully complete tasks necessary to making career decisions. Taylor and Betz (1983) chose as the basic construction Crites (1978) five career choice competencies for their Career Decision-Making Self-Efficacy Scale. The five subscales measuring career decision-making self-efficacy are: 1) accuracy self-appraisal; 2) gathering occupational information; 3) goal selection; 4) making plans for the future; and 5) problem solving. Taylor and Betz (1983) used 346 college students, including 156 students (68 males and 88 females) attending a private liberal arts college and 190 students (60 males and 130 females) attending a large state university. The purpose of the study was to examine the psychometrics of the scale. The initial results provided evidence the scale had good reliability and validity.

Career decision-making self-efficacy.

Researchers (Bullock-Yowell, McConnell, & Schedin, 2014) examined the effect on career concern differences between 226 undecided and decided college students. Eighty-three reported lower career decision-making self-efficacy, with 143 indicating higher incidence of negative career thoughts. Results showed undecided students are as ready to make a career-related decision as their decided counterparts, but may lack or be receiving inconsistent career information.

Moore's (2003) study used an iteration of Career Decision-Making Self Efficacy to examine the effect of career exploration courses on the career decision self-efficacy of students who were enrolled in different career exploration courses offered by two universities in the Midwest. College students enrolled in career courses during three

different academic terms participated in the study. The results of this study indicated a significant difference between the means of the pretest and posttest scores on the Career Decision-Making Self Efficacy scale, for each of the three academic terms: $t(189) = 4.863$; $t(85) = 2.962$; $t(101) = 3.809$.

Reese and Miller's study (2006) examined the effects of a career development course on career decision-making self-efficacy of 30 college students enrolled in a one credit hour career exploration course and 66 students enrolled in an introductory psychology course. The students in the two groups were compared on career decision-making self-efficacy. No statistically significant difference was found between the control and treatment group. Other research has explored antecedent or background and demographic variables related to career decision self-efficacy. One such variable is gender, for which a few significant differences in the total score have been reported in research on the CDSE (Betz, Klein, & Taylor, 1996; Taylor & Betz, 1983). This lack of gender differences implies gender homogeneity, rather than differences, in the background experiences related to development of perceived competency relative to career decision-making tasks, or if not homogeneity then some type of compensatory experiences or factors if there are differential background experiences.

In the GSS, the researcher examined career decision self-efficacy on STEM majors in a small group (N=178) of undergraduate college students. There were significant ethnic group differences. Most of the participants who completed the GSS study, the majority African-Americans were n=150 83% for Career Decision Self-Efficacy total scores were the most career self-efficacious, and were significantly larger

26

than the remaining 28 participants were from various ethnic groups. Females 114 were significantly larger than the remaining 64 participants were males.

Astin's involvement theory.

Astin founded the Cooperative Institutional Research Program (CIRP). CIRP has been instrumental in producing national studies on the influence of higher education on student development (Campbell, 2012). Astin's (1999) involvement theory came from his 1975 study of dropouts. He defined student involvement as the "amount of physical and psychological energy the student devotes to the academic experience" (p. 518). His study identified college environmental factors influencing student persistence. The findings of his 1975 study showed students remaining in college were involved on campuses and with faculty members, while students who failed to persist were less likely to be involved or have a sense of commitment to the institution or their program. Based on his findings, Astin (1999) suggested the following five reasons explained student attrition:

1. Involvement is the investment of physical and psychological energy in various objects. The objects may be highly generalized (the student experience) or highly specific (preparing for a chemistry examination).

2. Regardless of its object, involvement occurs along a continuum; different students manifest different degrees of involvement in a given object, and the same student manifests different degrees of involvement in different objects at different times.

3. Involvement has quantitative and qualitative features. The extent of a student's involvement in academic work, for instance, can be measured quantitatively (how many hours the student spends studying) and qualitatively (whether the student reviews and comprehends reading assignments or simply stares at the textbook and daydreams).

4. The amount of student learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program.

27

5. The effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement. (p. 519).

According to Astin's (1999) research, the major environmental factor involving persistence was residence, specifically living on campus. This factor positively influenced persistence among students of different races, abilities, background, and genders as well as among students attending various types of institutions. Astin noted involvement with professors in student organizations, extracurricular activities, sports, honors programs, ROTC, and research projects positively influenced student retention.

Retention was negatively connected to students who were employed in full-time jobs off campus. The data showed being employed in a part-time, on-campus job positively contributed to retention. Astin's (1999) study suggested students who were enrolled in two-year institutions were more likely to drop out because they commuted to classes and were less likely to have opportunities to be involved with faculty members (Astin, 1984). According to Astin, a stronger relationship exists between students and faculty members than other involvement.

The influence of involvement. Whether students receive support from strong social and academic networks as the transition from high school to college is dependent on personal, family, social, and economic factors (Adelman, 2006; Herndon, 2003; Martinez & Klopnett, 2005). African American students choosing to attend college often experience difficulty in choosing a major area of study leading to career opportunities. Research shows selecting a college major can be influenced by five variables: involvement, behaviors, self-efficacy beliefs, outcomes expectations, and goals.

28

Usher (2009) conducted a qualitative study to determine rules or heuristics eight middle school students used to select and interpret information on mathematics self-efficacy. Usher (2009) conducted semi-structured interviews with the eight students, their parents, and mathematics teachers. These students self-reported their self-efficacy in mathematics as either high or low. Students with high self-efficacy had achieved mastery of the mathematical concepts, while the opposite was true for students with low self-efficacy. Students with low mathematics self-efficacy struggle with learning and understanding the concepts taught. Usher found teaching structures, course placement, and students' self-regulated learning emerged as important factors to self-efficacy.

Lent, Singley, Sheu, Schmidt, and Schmidt (2007) conducted a study with 153 undergraduate engineering students to identify relationships among social-cognitive factors (milestone self-efficacy, coping efficacy, outcome expectations, environmental supports, and perceived goal progress) and academic satisfaction. Statistically significant correlations in a positive direction were found among all variables with academic satisfaction. These researchers found outcome expectations did not explain statistically significant variance in goal progress or academic satisfaction while self-efficacy and environmental supports were significantly related to goal progress and academic satisfaction. Lent et al. (2007) asserted the findings of their study were consistent with other studies on the relationships among self-efficacy, goal progress, and social support and academic or career-related satisfaction.

Schaub and Tokar (2005) expanded research on social cognitive career theory SCCT by exploring the relationship between personality traits and career interests and which self-efficacy and outcome expectations resulted from academic experiences. Their

research evaluated relationships among constructs associated with SCCT and the RIASEC themes developed from Holland (as cited in Schaub & Tokar, 2005). The participants in Schaub and Tokar's study included 209 female and 118 male students in graduate and undergraduate programs at a small, private university. A path analyses was conducted to examine how personality related to career interests and which self-efficacy beliefs and outcomes expectations draw from relevant learning experiences. Schaub and Tokar found strong support for Holland's themes, for the relationships between learning experiences, self-efficacy, and outcomes expectations. They also found the relationships between learning experiences and outcomes expectations were partially mediated by self-efficacy.

Flores and O'Brien (2002) used a path analyses study to determine the influencing variables of the following: acculturation level, feminist attitudes, mother's educational level, and mother's occupational tradition on nontraditional career self-efficacy among Mexican American adolescent females. In addition, the authors examined which nontraditional career self-efficacy, nontraditional career interests, parental support, and barriers to the prestige were associated with specific careers and career aspirations. According to Flores and O'Brien, these variables are considered important to career development for women. A secondary purpose was to gain data on female adolescents' personal characteristics, including career choices, post high school plans, college and university choice and reasons for those college and university choices. They found no significant paths between the background contextual variables of acculturation level, feminist attitudes, mothers' educational level, mothers' occupational tradition, and nontraditional career self-efficacy. The researchers also found acculturation level and

feminist attitudes had a significant positive effect on nontraditional career self-efficacy and parental support and perceived barriers were not statistically significant predictors of traditional career choice. Increased parental support and more positive feminist attitudes showed higher career goals, validating SCCT.

Lent, Brown, and Hackett (1994) conducted a meta-analysis to determine the interrelatedness of three aspects of career development "(a) formation and elaboration of career-relevant interests, (b) selection of academic and career choice options, and (c) performance and persistence in educational and occupational pursuits. These researchers developed 12 proposals (with associated hypotheses) to test the interrelatedness of these aspects. Their results provided added support for other studies in unifying social cognitive theory of career and academic interest, choice, and performance. Lent et al. (1994) suggested further research to validate their social cognitive career theory further.

Tang, Pan, and Newmeyer (2008) conducted a study to determine factors influencing high school students' career choices using social cognitive career theory. The participants included 141 freshman and sophomore students (81 female and 60 male), with a mean age of 15.6 (SD = .63) years. The participants completed a demographic survey including questions on career exploration activities. They also reported career interests as measured by Holland's Self-Directed Search (as cited in Tang et al., 2008) providing information on six occupational environments (realistic [R], investigative [I], artistic [A], social [S], enterprising [E], and conventional [C]. Career self-efficacy was measured using the Self-Directed Search instrument. Outcome expectations and career choice were also measured by the researchers. The researcher found female students reported significantly higher outcome expectations for occupations involving helping

31

people and expressing themselves (artistic and social). The male students had higher self-efficacy in career choices involving making things (realistic, investigative, enterprising, and conventional). Female students' career choices were more strongly moderated by outcome expectations than by interests. Male students need strong self-efficacy to pursue nontraditional occupations.

Smith (2002) conducted a path analysis study to determine the relationships among variables associated with the performance model of the social cognitive career theory. The variables examined included past performance, computer self-efficacy, outcome expectations, academic goal, and academic performance. Students ($N = 194$) at a large university in the Midwest took part in the study. The participants were administered four instruments: the Information Technology Proficiency Exam, the Computer Self-Efficacy Scale, the Technology Outcome Expectations Scale, and a Background Questionnaire. The study findings showed past performance was a significant predictor of academic performance. Smith (2002) suggested instructors could use pretest scores of former college students of past performance as indicators of course outcomes and differentiate instruction to the entry level of current students enrolled in their courses. Smith reported students should know their assessment results to help them assess their ability and set realistic goals for academic performance.

Lent et al. (2005) conducted a study to determine whether social cognitive career theory could be used to predict interests in engineering and choice of major areas of study among male and female university students at Historically Black Colleges and Universities (HBCUs) and predominately white institutions (PWIs). The participants included 487 students from three universities, of which two were HBCUs (one private

and one state university). Most students were first-year students with a mean age of 19.13 years. The majority of the college students enrolled at the three universities planned to major in engineering (computer, aerospace, or electrical). The participants completed instruments measuring self-efficacy, outcome expectations, interests, major choice goals, and social supports and barriers. The findings of this 3 x 2 multivariate analysis of variance (MANOVA) used to compare the males and females at the three universities provided statistically significant differences between variables, except social barriers. Students at the HBCUs reported significantly higher scores for self-efficacy, outcome expectations, technical interests, social support and educational goals than participants at the predominately white universities. When comparing men and women, the only statistical difference were social support and social barriers, with females having significantly higher scores for social support and significantly lower scores for social barriers. The results of the path analysis provided support for the SCCT variables. The findings suggested gender and university type were not moderating the predictive ability of the measures, supporting the SCCT variables were helpful in explaining major choice for both male and female students at the three universities. Lent et al. (2005) provided suggestions for further research including completing a longitudinal study of students from entering through conclusion of their degree programs to determine if the findings would remain consistent over the four years. This study contributes to the literature by exploring and combining two well-established theoretical frameworks - Astin's Theory of Student Involvement (1984) and Bandura's (1977) –to examine how various types of student involvement and self-efficacy works together to promote participates to continue to excel in their organization and join the workforce in STEM related careers. Facilitated

33

by its Astin's (1991) I-E-O data analysis framework, GSS study contributes to both to STEM literature and self-efficacy literature. By identifying number of factors input pre-characteristic from high school and family, college environment having an influence on undergraduate college students stem majors career decision making self-efficacy, by student members involved in profession organizations, student-to-student interaction and student-faculty interaction. Output students will graduate in STEM majors and enter in the STEM-related workforce. By conducting this study, provides an empirical rational for professional organization and colleges and universities, as well as public policymakers, to initiate and support evidence-based programs and interventions encouraging student members to pursue STEM careers.

Science, Technology, Engineering, and Mathematics (STEM) Education

The United States recently has faced a political and societal crisis because of the lack of students, teachers, and practitioners in the areas of science, technology, engineering, and mathematics. Many stakeholders called for reforming introductory STEM courses based on extensive research showing the substantial limitations associated with traditional, lecture-based instruction. New teaching methods in STEM courses led to major expenditures of time and money on research and development to improve STEM instruction (Henderson & Dancy, 2011).

STEM policy. Federal and state legislative efforts aim at improving STEM education in mathematics, natural sciences, engineering, and technologies (Kuenzi, Matthews, & Mangan, 2006; National Governors Association, 2007). There is concern about America's ability to keep its competitive position in the global economy renewed interest in STEM education. The NAS, the National Academy of Engineering, and the

34

Institute of Medicine in 2007 jointly issued a report ("Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future") calling for strengthening the STEM pipeline from primary through postsecondary education (NAS, 2007). This report also recommended increasing investments in STEM programs, improving the STEM teaching force, and increasing the number of students pursuing degrees and careers in STEM fields.

National studies on STEM. A report from The National Center for Education Statistics (2009), "Stats in Brief" focused on undergraduate students, examining students' persistence toward degree completion in STEM fields. This report was designed to provide a profile of undergraduates pursuing and completing STEM degrees. It addressed three questions: (a) Who enters STEM fields? (b) What are their educational outcomes (i.e., persistence and degree completion) several years after beginning postsecondary education? (c) Who persisted in and completed a STEM degree after entering a STEM field of study?

Three national studies have been published on STEM careers: Beginning Postsecondary Students Longitudinal Study (BPS: 96/01), National Postsecondary Student Aid Study (NPSAS: 04) and the Educational Longitudinal Study of 2002/06 (ELS: 02/06). These longitudinal studies provide information on characteristics of students pursuing degrees and careers in STEM. They were also designed to identify barriers preventing students from achieving their goals as well as facilitators helping students achieve their goals. These studies examined entrance into STEM majors among a more traditional college-age population. All findings reported were descriptive and did not involve any causal relationship. All comparisons in these studies were tested for

statistical significance using students' statistics to ensure differences were larger than expected because of sampling variation. All differences cited were statistically significant at the .05 level.

STEM employment by race. According to the United States Census Bureau's 2009 American Community Survey (ACS), about three of four STEM jobs (72%) are held by non-Hispanic Whites, nearing their representation in the United States workforce (68%). Non-Hispanic Asians made up 14% of all STEM workers, but only 5% of the United States workforce. Non-Hispanic Blacks and Hispanics each account for only 6% of all STEM workers, but 11% and 14%, of employment overall.

African-Americans have been earning STEM degrees at decreasing levels (NCES, 2012). According to the National Center for Education Statistics 2012 report, African Americans made up 12% of the United States population and 11% of all students enrolled in postsecondary institutions. African Americans in 2009 received just 7% of all STEM bachelor's degrees, 4% of master's degrees, and 2% of doctoral degrees in the United States (NCES, 2012). According to the National Center for Education Statistics in 2009, African Americans received 1% of degrees in science technologies, and 4% of degrees in mathematics and statistics. Of the 5,048 doctoral degrees awarded in the physical sciences, such as chemistry and physics, 89 were earned by African Americans, totaling less than 2%.

Student Involvement

Student Involvement Theory. Flowers (2004) conducted a study using data from the College Student Experiences Questionnaire (CSEQ) to explore the effects of student involvement on African American college students. The researcher used data gained from

7,923 African American college students enrolled at 192 postsecondary institutions who took part in the CSEQ. Results from the study showed African American college students had positive in-class and out-of-class experiences in student development. The study showed there were significant positive effects of student involvement on academic and social development. The study also validated Astin's (1984) theory of student involvement.

Case, Henck, Schreiner, & Herrmann (2011) used hierarchical multiple regression analysis to explore which combined independent variables best predicted student involvement at a private Christian liberal arts institution. The study included senior students who were attending colleges or universities and were members of the Council for Christian Colleges and Universities (CCCU). Data gained from students who took part in the 2002 and 2006 Comprehensive Assessment Project (CAP) were used in the study. The study used student's involvement in collegiate clubs and groups as the criteria for this study. Results of the study showed male students had higher career goals than female students. Female students were found to have higher aspirations of involvement in college and higher interactions with faculty.

Input Factors

STEM areas of study are typically regarded as difficult majors; however, studies have shown factors other than students' academic prowess have been shown to influence students in selecting college majors (Yazici & Yazici, 2010). These factors include family support, science and mathematics experiences, caring school agents and institutions, self-efficacy and personal commitment, social factors, interests and attitudes, goal and outcome expectancy, intelligence, and mentoring (Malgwi, Howe, & Burnaby,

37

2005). Each of these factors contributes to whether students remain in STEM majors and succeed.

Women in STEM careers. Blickenstaff (2005) explored 30 years of explanations and theories attempting to explain the absence of women in STEM majors and careers. Blickenstaff showed to improve the under-representation of women in STEM fields, educators should carry out the following suggestions:

1. Ensure students have equal access to the teacher and classroom resources.

2. Create examples and assignments emphasizing the ways science can improve life.

3. Use cooperative groups in class, or at least avoid dividing students by sex for class competitions or in seating arrangements.

4. Eliminate sexist language and imagery in printed materials.

5. Avoid sexist language or behavior in the classroom.

6. Increase depth and reduce breadth in introductory courses.

7. Openly acknowledge the political nature of scientific inquiry. (p. 384)

Blickenstaff (2005) stated factors discouraging women from choosing majors in STEM need to be addressed, with sympathetic teachers helping to break down the barriers in STEM related fields.

Espinosa (2011) conducted a quantitative study exploring the influence of precollege characteristics, college experiences, and institutional setting on the persistent of 1,250 undergraduate women of color (Hispanic [37%], African American [33%], Asian American [21%], American Indian and Alaska Native [5.8%], and Native Hawaiian and Pacific Islander [3.3%] at 96 institutions and 891 Caucasian women at 123 institutions. Results showed undergraduate college female student persisted in STEM

38

majors when they were satisfied with science and math coursework. Women of color joining a STEM-related student club and continuing to discuss course content outside class were more likely to continue to graduation. Female college students, regardless of race, leave STEM programs because professors fail to make science accessible.

Stout, Dasgupta, Hunsinger, and McManus (2010) conducted three studies on female college students' self-concept in STEM-related majors. Study 1 explored the interactions of 73 undergraduate female college students majoring in STEM disciplines at a large university. The study explored whether a fellow female or male peer expert would influence the females' self-concept and performance on a math exam. Stout et al. found female students were likely to have positive perceptions about math when interacting with a female math expert than a male math expert. The authors stated female students' self-esteem is protected when having contact with same-sex experts in their major study. Stout et al. examined the effects of a women identifying with a same-sex expert in the same STEM discipline. The study used data from 101 female undergraduate female engineering students to determine whether female students who identified with female experts in their field were likely to persist in their STEM major. The study results showed two variables, greater implicit identification with STEM and higher STEM self-efficacy were mediating the relationship between identification with a female expert and remaining in engineering academic programs. Stout et al. studied the effects of having same-sex STEM experts on self-concept and self-efficacy of female STEM students. Ninety-one undergraduate college students (42 females and 49 males) from 15 sections of an introductory calculus class took part in the study. Seven classes were taught by females and eight classes were taught by males. The results of the study showed women,

39

when taught by female math instructors, were more confident and earned higher grades than women taught by male math instructors. Stout et al. (2010) suggested female experts may prompt an approach-oriented response encouraging female students to remain in their STEM majors.

African American male college students. Moore (2006) studied African American males' decision to persist in college and pursue engineering as a career. He found specific factors were influential in determining decisions to persist and earn a bachelor's degree in engineering. These factors included committing to engineering, familial support, integrating social and academic environment, connecting or linking with academic resources, goals with a realistic action plan, regular interaction with African American and non-African American peers, and racial identity. If these factors were low or absent, African American males were less likely to persist in completing a degree in engineering and were likely to change majors or drop out of college.

Race

Latino students in STEM majors. Cole and Espinoza (2008) conducted a longitudinal study on factors influencing academic performance among students who have declared STEM majors. They found high school GPA was significantly positive correlated with college GPA of Latino students majoring in STEM.

Persistent trends in educating African Americans. According to the NCES (2003), the following trends exist in educating African Americans. Students often underachieve or achieve at lower in science and mathematics and are substantially underrepresented in STEM majors and careers (American Association for the Advancement of Science [AAAS], 1998; Moore, 2000; Russell & Atwater, 2005).

African American females in 1998 accounted for 9.7% of bachelor's degrees awarded to females in science and engineering. African American males earned 5.7% of bachelor's degrees in science and engineering awarded to males (Hill, 2001). Studies examining differences in academic achievement between females and males have grown recently. The literature has shown gender influences educational outcomes (Flowers, Osterlind, Pascaerella, & Pierson, 2001). National data found differences in females and male students enrolled in STEM majors (National Science Foundation, 2008). Figure 3 presents the percentage of students who received bachelor's degrees in STEM disciplines during the 2009-10 academic years.

At Historical Black Colleges and Universities (HBCUs), males made up nearly 60% of all STEM majors. Females earned more degrees in STEM (National Science Foundation [NSF], 2008), and African American males' perceptions of how educators' perceive them had profound effects on their educational goals (Flowers, Milner, & Moore, 2002; Henfield, Moore, & Wood, 2008; Moore, 2006; Moore, Madison-Colmore, & Smith, 2003).

Parent involvement. Cullaty (2011) conducted a study using semi-structured interview sessions to explore parental involvement influencing developing autonomy among college students. Data were collected from 169 third-year students who completed a survey on parent involvement at a flagship state university in the Southeast. Eighteen

41
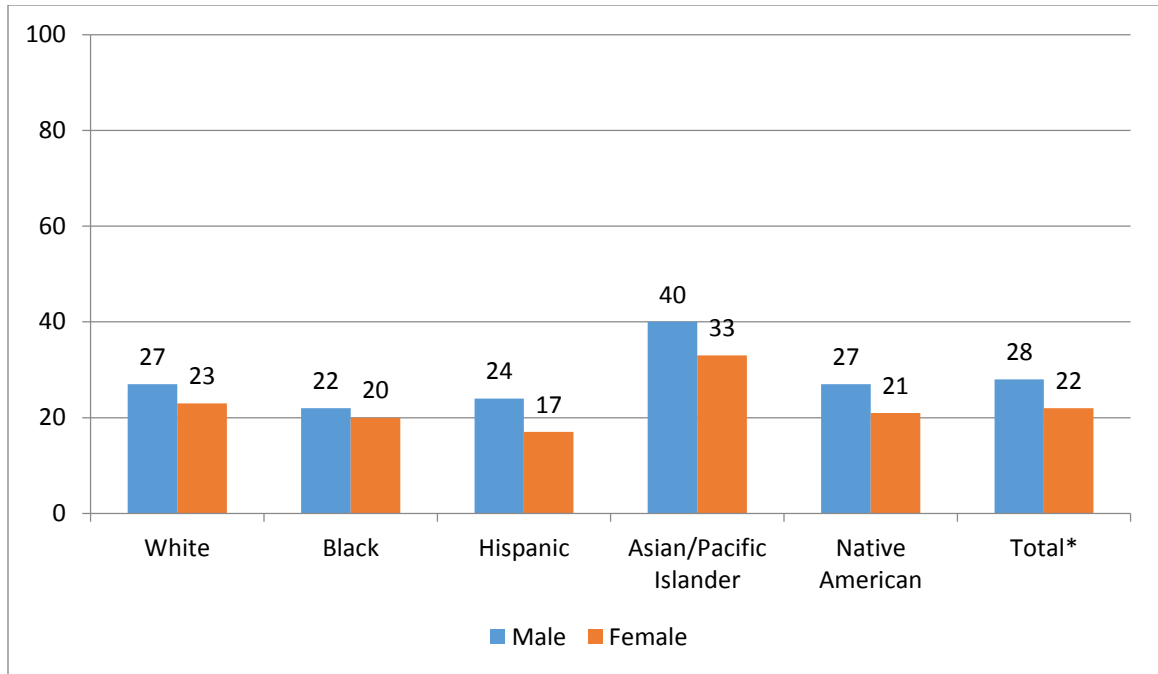
*Total includes other racial and ethnic groups not shown separately in the figure.

Figure 3 Percentage of bachelor degrees conferred by degree-granting institutions in science, technology, engineering, and mathematics (STEM) fields, by race and ethnicity and gender. Academic Year 2009-2010 (Source: U. S. Department of Education, National Center for Education Statistics. Integrated Postsecondary Education Data System (IPEDS), 2012, p. 207.)

students were selected using purposeful sampling. The students were divided into three

groups: high parental involvement, medium parental involvement, and low parental

involvement. The students took part in three interview sessions and wrote two journal

entries following the first and second interviews. Using NVivo7 software to analyze the

journal entries and transcripts of the interviews, researchers identified three themes. The

first theme was autonomy development in supportive relationships with parents. The

second theme involved three parental behaviors promoting college students' autonomy

development: "actively redefining the parent-student relationship, relinquishing

unnecessary control, and encouraging responsibility" (p. 431). The final theme involved

42

parental behaviors inhibiting autonomy development among college students. The study participants expressed close positive interactions with their parents. Some participants noted their parents did not provide support.

Mao (2012) conducted a study to determine if personality characteristics or parental support could be used as predictive indicators of career self-efficacy of the study involved 435 college students. They completed three surveys: Parental Support Scale, the Career Self-efficacy Scale, and the Holland Personality Scale. The findings confirmed four of six personality characteristics (conventional, investigate, social, and artistic) were predictors of career self-efficacy. The study results showed the esteem and autonomy support factors identified by the parental support scale were statistically significant predictors of college students' career self-efficacy. Parental support promoting self-esteem and autonomy has been shown to improve students' self-confidence and self-efficacy in choosing career majors.

McCarron and Inkelas (2006) conducted an exploratory study of the importance of parental involvement for first-generation and non-first-generation college students. The researchers examined collected data from 1,879 college student surveys about the influence of parent involvement from the 1988-2000 National Educational Longitudinal Study was distributed by the National Center for Education Statistics (NCES). The study examines differences in educational goals for first-generation college students and the role of parental involvement. Using a block design multiple linear regression analysis, the researchers entered parental involvement on the third block. Study results showed perception of the importance of good grades accounted for increased variance in educational goals among first-generation students. Parental involvement was the second

43

strongest predictor for both first generation and non-first-generation college students, offering evidence parental involvement is important for college students.

Environmental Factors

Environmental factors are associated with the experiences a student would have during college (Astin, 1991). These factors include interactions with other students, peer mentoring, interaction with faculty, and mentoring.

Student-student interaction. Kellogg and Smith (2009) conducted a case study on student-to-student interactions among students enrolled in an online MBA data analysis course. The students' mid-term course evaluations were analyzed to determine learning from student-to-student interactions while working on group projects in the class. Fourteen percent of the students stated they learned most from other students, while 80% of the students learned most from independent study activities while interacting with course materials. The themes emerging from the evaluations showed time inefficiency, interaction dynamics, and flexibility intrusion were reasons student-to-student interactions were ineffective in the data analysis course. One student explained group work was frustrating because of scheduling problems. Students stated reaching a consensus on a final draft of a case study was difficult and time-consuming.

Peer mentoring. MacGuire and Halpin (1995) conducted a qualitative study identifying pre-engineering experiences among students at Auburn University. During the study, the College of Engineering was the second largest college in Auburn University. The College of Engineering in 1994 had an enrollment of 4,084 students and 747 students were enrolled in pre-engineering courses. This group included 181 females and 566 males, the majority were Caucasian (90%) students. African American students made up

10% of students in these pre-engineering courses. The researcher interviewed 24 students. The students were equally divided into two groups: (a) those persisting in engineering and (b) those having switched majors. Factors influencing persistence included dedication, hard work, strong study skills, and a solid background in math and science. They found freshmen students who were mentored had a more successful transition and adjustment to college and were more likely to persist in engineering. Students who switched majors showed they were not prepared for the rigors of college including large class sizes, lack of faculty support, and the work required in the pre-engineering courses.

Student-faculty interaction. Cox and Orehovec (2007) conducted a qualitative study using a multi-method research design. They conducted focus groups, interviews, and research observations at a residential college in a large public research university. Their study used case study and grounded theory approaches to explore interactions between graduate and undergraduate students and faculty over thematic teas and required dinners held at the university and voluntary ethnic dinners held off campus. They used a semi-structured interview protocol to explore faculty and student interactions. The researchers concluded student and faculty interactions could be grouped into five categories: (a) disengagement, (b) incidental contact, (c) functional interaction, (d) personal interaction, and (e) mentoring. Their findings suggested faculty-student interactions outside the classroom were still elusive on many campuses, with little out-of-class interactions between students and faculty.

Criado-Gomis, Iniesta-Bonillo, and Sanchez-Fernandez (2012) conducted an empirical research designed at two Spanish universities. The researchers used an 11-point

45

Likert scale to classify communication through teaching support, administration communication tools. A random sample of 500 students from each university was selected. Students were interviewed using a Computer Assisted Telephone Interview (CATI). Results show ICT usage confirms a positive influence on the quality of faculty-student interactions. The findings also provided evidence students had a positive experience at their universities.

Kim and Sax (2009) conducted a retrospective study using data collected from the California Undergraduate Experience Survey (UCUES) to compare the frequency of student-faculty interactions and student satisfaction with faculty. The researchers explored effects of student-faculty interactions on six student outcomes: "(a) academic achievement, (b) educational aspirations, (c) affective response to college, (d) intellectual and personal development (i.e., college grade point average [GPA], degree aspiration, and integration), (e) two self-reported gains in skills (critical thinking and social awareness), and (f) satisfaction with overall college experience" (p. 459). The researchers also explored the effect of such interactions varied by students' gender, race, social class, and first-generation status. The study used data of 58,281 students who took part in the 2006 UCUES. The results showed differences in the frequency of student-faculty interaction across student gender, race, social class, and first-generation status. Results showed Asian American students were more likely than African American, Latino, and Caucasian students to volunteer assisting faculty members with research. African American students were the most likely to communicate with faculty outside class about the course and through email. African Americans students also interact more with faculty members during lecture class sessions than with students from other ethnic groups.

Gender differences were statistically significant. Male students have higher agreement on four of six forms of student-faculty interaction.

Tatum, Schwartz, Schimmoeller, and Perry (2013) used a non-experimental, descriptive research design to examine student-faculty interactions. The researchers explored gender differences in students' levels of interaction with faculty in a classroom. They used a 2x2 multivariate analysis of variance (MANOVA) to determine whether four student behaviors (call out, raises hand, willingly responds, and asks student questions) and four faculty behaviors (called on, correction, follow-up, and praise) differed between male and female students in classes taught by both male and female faculty. The participants included 158 college students enrolled in 14 sections of interdisciplinary first-year seminar classes. Results showed no significant interaction between student gender and professor gender. A significant multivariate effect emerged for professor gender. The percentage of males in the classroom was negatively correlated with voluntary call-outs. Findings based on student evaluations suggested positive interactions between student and faculty members based on gender. Female professors received more positive feedback from female student than male students. Tatum et al. concluded female professors were more likely to interact with students than male professors.

Mentoring. Wilson et al. (2012) examined the effectiveness of the Howard Hughes Medical Institute (HHMI) Professors programs at Louisiana State University on keeping students in STEM majors. The mentoring program was intended to help underperforming students to use metacognitive strategies to improve their performance in STEM courses and their programs. The program integrated mentoring, research, and education components to influence student retention and "(a) academic performance in

47

undergraduate coursework, (b) self-image, (c) pre-college background, (d) academic advising, (e) financial support, and (f) social integration in the STEM culture" (Wilson et al., 2012, p. 150). The majority of students were African American (52%) with grade point averages from 2.5 to 3.0. The students needed to have an interest in pursuing careers related to STEM and be committed to the mentoring program. The outcomes of the program were determined by comparing 60-year graduation rates among students who took part in the LSU-HHMI program with nonparticipating undergraduates, and a nationwide sample of college students. The results showed students in the mentoring program were more likely to complete their college programs in six years, with African American students more likely to complete their STEM program than nonparticipating undergraduates or the nationwide sample of college students.

Turban, Dougherty, and Lee (2002) conducted a correlation analyses to determine whether the effects of gender, race, and perceived similarity were related to doctoral student perceptions of mentoring received. Surveys were completed by 303 doctoral students and 151 faculty advisors. Researchers were able to analyze data for 202 student-faculty dyads. The majority of students (68%) and faculty advisors (88%) were White. Among the students were Asian and Pacific Islanders (20%), Blacks (7%), Hispanics (5%), and Native Americans (1%). Included in the faculty sample were Asian and Pacific Islanders (9%), Native Americans (2%), and Hispanics (1%). Nine mentoring functions were identified by Kram (Turban et al., 2002) were gained from several researchers who studied mentoring in business settings. Their surveys were adapted to reflect mentoring relationships between students and faculty in academic environments. Using a factor analysis, researchers identified four factors (psychosocial mentoring, exposure and

48

visibility and sponsorship, challenging assignments, protection and assistance) were used to examine the relationships between the students and their faculty advisors. Study results showed students were in relationships with advisors of the same gender and sex. Turban et al. (2013) found the length of the relationships among doctoral student-faculty advisor dyads moderated the effects of gender similarity and perceived similarity on mentoring received.

Output Factors

According to Astin (1991), outcome factors include student's characteristics, knowledge, attitudes, beliefs, and values resulting from attending college. These factors emerge from the input and environmental factors influencing college students. For this study, the outcome variables include choice of college majors and academic success for STEM majors.

Choice of college majors. Trusty and Ng (2000) used data from the National Education Longitudinal Study: 1988-94 to determine the longitudinal influence of students' perceptions of achievement in English for women and achievement in mathematics for men on choice of college majors. The study data involved 7,953 late adolescents. Participants attended various colleges and universities. The perceptions of the adolescents on English and mathematics achievement were gained when the students were in the 10th grade. The students' college majors were classified into the six Holland types (R – Realistic; I – Investigative; A – Artistic; S – Social; E – Enterprising; C – Conventional; Trusty & Ng, 2000). The control variables in the study were gender and socioeconomic status (SES), and SES determined by weighting parents' income, education and occupation. Students' SES scores were classified into four levels from low

49

to high. Using a Chi-squared Automatic Interaction Detector (CHAID) to analyze the data, researchers found women's choices of majors were influenced by their perceived English achievement, while men chose based on their perceived mathematics achievement. Women with lower SES levels and men with high SES levels were more likely to choose their majors based on their perceived mathematics achievement. According to Trusty and Ng (2000), gender and SES interactions are important parts of career development theory. These researchers also suggested women and men with low SES, influenced by perceived achievement in mathematics, should be further studied to determine whether college students with low SES were likely to persist in mathematics majors. They also suggested exploring whether their perceived academic achievement is associated with persistence to complete their education.

Academic success for STEM majors. Whalen and Shelley (2010) conducted a longitudinal study on influences on the retention underrepresented students who declared STEM majors. Using the entering freshman class (N = 4,271) at a "research university with high research activity" (p. 47), Whalen and Shelley explored variables, using Astin's I-E-O model (input, environment, and outcomes), from the registrar's student information file to predict graduation within six years of entry into a college program. The variables included gender, ethnicity, in-state residency, total high school language credits, high school rank, ACT scores, years student lived on campus, membership in a university learning community, average loan aid, average gift aid and average work study aid. Other variables included average budgeted need, and major (STEM or non-STEM), and GPA for the most recent registered term. The dependent variable was six-year retention and graduation. The underrepresented students who declared STEM majors (female or

50

minority students) were less likely to be retained or graduate in six years of entry than White male students majoring in a STEM discipline. Whalen and Shelley (2010) found students majoring in STEM fields had higher ability levels (as evidenced by higher GPAs and ACT scores), because of the difficulty of coursework in STEM disciplines. Fewer students majoring in STEM were retained or graduated in the six-year time frame than students majoring in non-STEM programs. Whalen and Shelley (2010) recommend further research to determine which characteristics can help students majoring in STEM programs to complete their baccalaureate degrees successfully. Table 3 presents bachelor's degrees for each of the major STEM areas.

Summary

Extensive research has been conducted showing self-efficacy and career choice is a strong predictor of whether college students will complete STEM majors. There is a specific gap between studies examining both career choice and self-efficacy among college students majoring in STEM and the factors influencing their decisions to major in STEM and pursue STEM-related careers. The review of literature was useful in determining the items be included in the online survey including career choice and self-efficacy to (a) explore and determine which factors influence college students to persist in a STEM major and (b) identify reasons for their decisions to major in STEM and pursue STEM-related careers.

Chapter 3 presents the suggested methods including a description of the sample, the instrument used, and the procedures for collecting and analyzing data.

Chapter Three

Methodology

Introduction

This chapter presents the methodology used to collect the data needed to conduct appropriate suitable analysis and address the research questions. Descriptive statistics were used to provide participant profiles. Inferential statistical analyses, including a blocked form of stepwise multiple linear regression analysis was used to determine whether STEM self-efficacy can be predicted from personal and family characteristics, choice variables, student-to-student interactions, and faculty-to-student interactions.

Research Design

This research study used a non-experimental correlational research design to collect information on the factors influencing participants' decision to pursue STEM majors. A blocked form of stepwise regression analysis was used in this study. This research design is used when examining relationships among variables (Creswell, 2005). According to Creswell, correlational research designs are used for studies where data are collected at one time, and participants are analyzed as a group. The independent variable is not manipulated in this research design. The research questions for this study included the following:

RQ1. What influence, if any, do student demographic characteristics have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ2. What influence, if any, do major choice variables, have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ3. What influence, if any, do student-to-student interactions have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ4. What influence, if any, do faculty-to-student interactions have on career-decision-making self-efficacy?

RQ5: What influence, if any, do high school variables have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ6: What influence, if any, do college variables have on career-decision-making self-efficacy among undergraduate STEM majors?

The dependent variable explored in this study was career decision-making self-efficacy as measured by the Career Decision Self-Efficacy Scale (Betz & Taylor, 2012). The independent variables included decision-making factors (intrinsic, extrinsic, and others) as measured by the "Why I Chose to Major in STEM" section adapted from results of a Harris poll conducted for Microsoft Corporation. Student-student interactions and faculty-student interactions were included as environmental independent variables as part of Astin's (1984) I-E-O model. These variables appeared in previous literature on influencing student retention in college and influence college outcomes (Campbell, 2012).

The demographic questionnaire developed by the researcher included various independent variables: personal variables (age, gender, ethnicity, student status), family variables (parents' education, parents' occupation, family income, family composition, and number of siblings), educational variables (high school [high school type, curriculum, high school location, ACT or SAT outcomes, self-reported grade point average, participation in extracurricular activities, number of students in graduation class]

and college and university [student status [in credit hours], studying time in college, STEM major, college grade point average, attended a community college, membership in organizations, current major, participation in STEM-related organizations, educational aspirations]). These variables were selected as input variables because of previous literature by Astin (1984) found these variables influenced college entrance and completion. Table 4 presents the dependent and independent variables reflecting three components of Astin's I-E-O model.

Participants

The participants in this study included college students who are majoring in STEM related disciplines (biology, chemistry, physics, engineering, and mathematics, etc.). The participants included males and females age 18 years to about 25 years old. The sample made up various culturally self-identified ethnic and racial backgrounds (e.g., African American, Caucasian, Hispanic, Asian, and Native American.). Participants were located throughout the United States and were members of the National Organization of Black Chemists and Chemical Engineers (NOBCChE), Charles Drew Science Scholars Program (CDSSP), and Michigan Lewis Stokes Alliance for Minority Participation (MI-LSAMP).

Participant Selection

Eight organizations were contacted to determine their willingness to help in data collection). Of this number, three organizations agreed to allow the researcher access to their listservs. The researcher asked for a listserv of their student membership rosters and a mention of the study placed in their journals or on their websites.

54

Table 4

Dependent and Independent Variables – I-E-O Variables

Independent Variables	Input	Personal Characteristics Age Gender Ethnicity Family Variables Parents' educational levels Parents' occupations Family composition Family income Number of siblings High School Variables ACT/SAT score High school type Took International Baccalaureate courses Took Advance Placement/Honors courses Location of high school Gender make up of high school Number of students in graduating class Self-reported high school GPA Hours spent daily studying in high school Participate in extracurricular activities in high school College Variables Number of credit hours completed Educational goals Number of hours spent studying in college Current major Self-reported college GPA Attended a community college before baccalaureate college Participation in STEM-related activities Membership in college organizations Reasons for choosing a STEM major Potential salary Job potential Passion for science Challenging major Good grades for science Make a difference Need for science graduates Family member influence Teacher and mentor Parents' influence
Independent Variables	Environment	Student-to-student interactions Faculty-to-student interactions
Dependent Variable	Outcome	Career decision making self-efficacy (STEM)

55

Instrument

Goff's STEM Survey (GSS) survey instrument was used in this study (See Appendix A). The survey was the result of consolidating several surveys and/or information from other instruments. The literature review identified important factors needed for this research. The GSS was divided into four sections. The first section included demographic items developed to gain personal, family, and educational information from students majoring in STEM disciplines. The second section included the Career Decision Self-Efficacy Scale (Betz & Taylor, 2012) measuring students' self-efficacy in career decisions. The third section included researcher-adapted items designed to draw out information about the reasons college students decided to choose STEM majors. This section was adapted from a Harris survey developed for Microsoft Corp. The fourth section measured student-student interactions and faculty-student interactions.

Section 1. Demographic Variables.

The demographic section of the GSS gained personal and educational background information used as independent variables. The variables included (age, gender, ethnicity, student status), family characteristics (parents' education and occupation, family income, family composition, and number of siblings), educational related variables (high school [high school type, type of curriculum, location of high school, ACT or SAT outcomes, self-reported grade point average, participation in extracurricular activities, number of students in graduation class] and college and university [student status [in credit hours], studying time in college, STEM major, college grade point average, attend a community college, membership in organizations, current major, participation in STEM-related organizations, educational goals]). The GSS used forced-choice responses for all items,

56

except age, grade point average, and SAT or ACT scores, which used fill-in-the blank response formats. These demographic characteristics influence determining students' persistence in college (Astin, 1984; Flowers, 2004; Moore, 2003; Tinto, 1993, 1997).

Section 2. Career Decision Self-efficacy Scale (CDSES; Betz & Taylor, 2012).

The GSS based on two theoretical constructs, self-efficacy (Bandura, 1977) and career maturity theory (Crites, 1978). Taylor and Betz (1983) used two theories as the foundation for defining career-decision self-efficacy and the skills used in making decisions about career choice. According to Taylor and Betz (2012), career maturity is based on five competencies: (a) accurate self-appraisal, (b) gathering occupational information, (c) goal selection, (d) making future plans, and (e) problem solving. These are the same competencies measured by the GSS. Career decision self-efficacy was developed by combining the two theories, self-efficacy from clinical and social psychology and career maturity from counseling and vocational psychology.

The original CDSES had 50 items using five subscales to measure the five competencies of career maturity. Betz, Klein, and Taylor (1996) reduced the items on the scale to 25 by removing five items from each of the five subscales, self-appraisal, occupation information, goal selection, planning, and problem solving. The items retained met specific criteria:

(a) substantive generality (versus content specificity or narrowness); (b) item –own scale correlation equal to or above .50; (c) loading on suitable factor (only in Taylor & Popma [1990] factor analysis); and (d) retention recommendations of Gati, Osipow, and Fassa's (1994) split scale analysis of the subscale structure (Betz & Taylor, 2012, p. 5).

Scoring. The items on the CDSES are rated using a 5-point Likert-type scale ranging from 1 for no confidence to 5 for complete confidence. The numeric responses for each item on the scale are totaled and divided by 25 to get a mean score. Using a mean score provides a score reflecting the original measuring scale (from 1 to 5).

Reliability. The instrument has been tested for internal consistency with college students from a large state university and a small private liberal arts college (Taylor & Betz, 2012). The alpha coefficients ranged from .80 for problem solving to .84 for goal selection and planning. The alpha coefficient for the total score was .95 providing evidence the instrument showed good to excellent internal consistency testing reliability. Luzzo (1996) tested the CDSES-SF for stability at a six-week interval. The correlation between the pretest and posttest was .83, showing the instrument reflected good stability. The internal consistency of the responses on the current study was tested. The resulting Cronbach alpha coefficient of .95 was evidence of excellent internal consistency as a measure of reliability.

Validity. The CDSES was tested for content, concurrent, and construct validity. Content validity was gained by developing the survey items based on career maturity. The domain of interest was defined, with the survey items developed based on the theory.

A confirmatory factor analysis was used to support the five-factor model, as well as a one factor general model. Miller, Roy, Brown, Thomas, & McDaniel (2009) asserted the CDSES was developed based on a strong theoretical model of career maturity (Crites, 1978); the five-factor model was suitable.

Construct validity was determined by correlating the CDSES and CDSES-SF with measuring career decision making and career indecision. The correlations between the

CDSE and career indecision were negative and low, providing support the CDSES had good construct validity. Betz, Klein, Klein & Taylor (1996) showed the strongest predictor of career indecision was CDSES-SF scores. A statistically significant difference was the CDSES-SF between students who had declared major and those who remained undecided (Gloria & Hird, 1999).

Robbins (1985) examined the construct validity of the CDSES using the known group's method. The students were divided into two groups (high and low vocational identity) based on their scores on the My Vocational Situation scale. The high and low identity groups differed significantly on the goal selection, planning, and self-appraisal subscales and the CDSES total score.

The scores on the CDSES-SF were significantly correlated to subscales from the Krumboltz's Career Beliefs Inventory (CBI; Luzzo, Hasper., Alber, Bibby, & Martinelli, 1999). Statistically significant relationships in a negative direction were found between CDSES scores and fear of commitment. Based on these findings, it appears the CDSES has validity and reliability.

Section 3. Why I Choose to Major in STEM.

No published instruments were found to determine why a college student would chose to major in science, technology, engineering, and mathematics (STEM). The instrument, "Why I Choose to Major in STEM," was developed by the researcher to fill this gap and incorporated into the GSS. The instrument was adapted from the results of a Microsoft sponsored Harris Interactive (Microsoft, 2011) poll asking 500 college students from 18 to 24 years old to state reasons why they decided to pursue STEM majors. The Why I Choose to Major in STEM includes 13 reasons why a student would major in

59

STEM, with a 14th item allowing the participant to enter other reasons. The reasons included on the instrument had been the most important reasons college students reported on the Harris Interactive (Microsoft, 2011) poll. The items on the scale measure three factors influencing the selection of STEM as a major:

- Intrinsic (It is my passion, STEM major are intellectually stimulating and challenging, I have always enjoyed games, toys, books about science, I received good grades in science and math in high school, I want to make a difference),

- Extrinsic (Good starting salary out of college, the job potential is good, our country is in need of college graduates who are focused on science and mathematics) and

- Others (a family member has similar education or career, I was encouraged by a teacher or guidance counselor, my parents told me I had to major in STEM, a mentor encouraged me to pursue STEM as a major; Microsoft, 2011).

The importance of the items are rated using a 5-point Likert-type scale ranging from 1 for least important to 5 for most important.

Before using this scale, it was examined for face validity by having three counselors read the items and comment about their suitability in measuring why students would major in STEM. These counselors were asked to offer suggestions for rewording any items and deleting or adding items they thought might strengthen the instrument validity.

60

The internal consistency of the survey was tested using Cronbach alpha. The obtained alpha coefficient of .84 for the present study provided evidence that the survey had adequate internal consistency.

Section 4: Student-to-Student and Faculty-to-Student Interactions

Nine items measuring student-to-student interactions were gained from Campbell (2012). Four of the items were concerned with face-to-face interactions, five on technology use to communicate with other students. The items on this scale are measured using a 4-point scale, ranging from 0 for never to 3 for daily. The responses on each section were totaled and divided by the number of the section to gain a mean score.

Nine items measure faculty-to-student interactions (Campbell, 2012), five items concerned with occurrences of interactions between faculty and students. These five items are rated using a 4-point scale ranging from 0 for never to 3 for 4 times or more during the last semester. Four items are used to determine students' perceptions of the likelihood of interactions with faculty members. These items are rated using a 4-point scale ranging from 0 for not likely to 3 for very likely.

The items were previously used in a dissertation by Campbell (2012). No information was provided on the validity and reliability of the items on this section of the survey.

Pilot Test

A pilot test of the Goff's Stem Survey (GSS) was used to determine the time needed to complete the instruments. Five participants were asked to complete the GSS, record the start and finish time to determine the total time used to respond to all survey items. The participants were chosen because fit the research criteria and were randomly

61

selected from a pool of 20 participants. The participants were asked to state if any items were difficult to understand and need rewording. The responses to the pilot test were used to revise the instrument before sending survey links to the student members of the selected organizations.

Data Collection Procedures

After receiving approval from the University of Toledo Institutional Review Board, the researcher prepared the survey on the SurveyMonkey website. The researcher included a copy of the informed consent form including a question indicating if participants read and understood the consent form. If the respondent answered "yes", they were forwarded to the survey. A "no" response closed the website. To collect data for this research project, the link to an online survey (e.g., SurveyMonkey) was sent by email to participants. This first email informed participants they have been randomly selected as participants in a doctoral study exploring factors influencing the decision to pursue a STEM career. The email invited participants to access the survey website and complete the survey. Following a two-week period, a second email with the same survey URL was sent to participants to remind them to complete the survey. This second email thanked the participants who took part and reminded those who did not respond on the importance of this study and the need to take part. After one added week, a third and final email with the same survey link was sent to the participants. This final email informed participants of the importance of their participation in the study and this was the last opportunity to take part in the survey. The results of the survey responses were collected and stored in SurveyMonkey password-protected website and only accessible to the researcher and other qualified members of the research team. At the end of the survey, the participants

were asked if they wanted to be entered into a drawing for three $50.00 debit cards. If they answered yes, SurveyMonkey guided them to a place to enter their email addresses not connected to the survey. The program randomly selected three email addresses at the end of the data collection period to receive the debit cards.

Data Analysis Procedures

The data from the instrument was downloaded from SurveyMonkey and converted into an SPSS file for statistical analyses. The data was cleaned and checked for errors before beginning the analysis.

A missing values analysis was used to determine the extent of missing values. If a participant did not complete the instrument and had not responded to more than 20% of the items, he or she was removed from the study. After scoring the data using the researcher's protocols, the data was scanned for missing values. If a variable had 10% or less missing values, the mean score for the variable was used for the missing values. If more than 10% of the scores were missing, the variable was removed from the study.

The demographic data was analyzed for frequency distributions and measuring central tendency and dispersion to provide participant profiles. The scaled variables were summarized using descriptive statistics to determine if they violate the assumption of normality for parametric testing. If the variables were skewed, then a square root or log transformation was used to normalize the data.

A blocked form of stepwise regression analysis using a stepwise variable entry method was used to address each research questions. All decisions on the statistical significance of the findings were made using a criterion alpha level of .05. The statistical analyses used to address the research questions are presented in Table 5.

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Table 5

Statistical Analyses

Research Questions	Variables*	Statistical Analyses
1. What influence, if any, do student demographic characteristics have on STEM self-efficacy?	Dependent Variable **Output** Career Decision-making Self-efficacy Independent Variables **Input** Block 1 Personal Characteristics • Age (8) • Gender (9) • Ethnicity (10) • Block 2 Family Characteristics Parents' educational levels (16) Parents' occupations (17, 18) Family composition (20) Family income (19) Number of siblings (21, 22) Block 3 High School Variables ACT/SAT score (35) Type of high school (24) Took International Baccalaureate courses (28) Took Advance Placement/Honors courses (29, 30) Location of high school (25) Gender composition of high school (26) Number of students in graduating class (27) Self-reported high school GPA (32) Hours a day spent studying in high school (33) Participate in extracurricular activities in high school (34) Block 4 College Variables Number of credit hours completed (11) Educational aspirations (12) Number of hours spent studying in college (37)	A block form of multiple linear regression analysis using stepwise variable entry will be used to determine which of the demographic variables predictors of career decision-making self-efficacy were. For variables that are categorical, dummy coding will be used to allow their use in multiple linear regression analyses.

64

Research Questions	Variables*	Statistical Analyses
	Current major (14) Self-reported college GPA (36) Attended a community college before baccalaureate college (??) Participation in STEM-related activities (38) Membership in college organizations (??)	
2. What major choice variables, if any, have an influence on STEM self-efficacy?	<u>Dependent Variable</u> **Output** Career Decision-making Self-efficacy <u>Independent Variables</u> **Input** <u>Block 1</u> • Potential salary (3.1) • Job potential (3.3) <u>Block 2</u> • Passion for science (3.4) • Challenging major (3.2) • Good grades for science (3.7) <u>Block 3</u> • Make a difference (3.8) • Need for science graduates (3.9) <u>Block 4</u> • Family member (3.10) • Teacher/mentor (3.11, 3.13) • Parents (3.12)	A block form of multiple linear regression analysis using stepwise variable entry was used to determine which of the factors are predictors of career decision-making self-efficacy
3. What influence, if any, do student-student interactions have on STEM self-efficacy?	<u>Dependent Variable</u> **Output** Career Decision-making Self-efficacy <u>Block 1</u> **Environment** • Study with other students (4.1) • Tutor other students (4.2) • Participate in student organizations (4.3) • Socialize with other students (4.4) <u>Block 2</u> • Technology to communicate with other students (5.1, 5.2, 5.3, 5.4, 5.5)	A block form of multiple linear regression analysis using stepwise variable entry was used to determine which of the student-to-student interactions are predictors of career decision-making self-efficacy
4. What influence, if any, do faculty-student interactions have on STEM self-efficacy?	<u>Dependent Variable</u> **Input** Career Decision-making Self-efficacy	A block form of multiple linear regression analysis using stepwise variable entry was used to determine which of the

65

Research Questions	Variables*	Statistical Analyses
	Independent Variables **Environment** <u>Block 1</u> • Communicate with instructor via email (6.1) • Discussed grades or assignments with instructor (6.2) • Discussed career plans with instructors (6.3) • Discussed ideas with instructor (6.4) • Received prompt feedback from instructors (6.5) <u>Block 2</u> • Worked with faculty on research project as part of course or program requirements (7.6) • Worked with faculty on research project outside of course or program requirements (7.7) • Been mentored by a faculty member at a professional conference or meeting (7.8) • Interacted with a faculty member in a professional organization, on publications, or in student government (7.9)	faculty-to-student interactions are predictors of career decision-making self-efficacy

*Survey items are noted in parentheses next to variables.

Summary

This chapter presented the research design used for this study, participants, and variables in the study, instruments, data collection procedures, and data analysis procedures. Data analysis results were used to summarize and analyze the data needed to describe the sample and address the research questions presented in Chapter 5. Survey research was used to determine if STEM self-efficacy can be predicted from personal and family characteristics, choice variables, student-to-student interactions, and faculty-to-student interactions. Three instruments were used in the study: a demographic

66

survey for gaining personal and educational information; a Career Decision Self-Efficacy scale to measure students' self-efficacy in making career decisions; and a researcher-developed survey to gain information on why students choose STEM majors. Items on the survey measured three factors influencing selecting STEM as a major: input, environment, and output. After survey results were collected, the data was analyzed to determine what influence, if any, the identified factors had on participants when they chose a major leading to a career in a STEM-related field.

After data collection, the predictor variables were organized into blocks replicating Astin's (1993) study of undergraduate student involvement. Data was analyzed using the CAMBRA method of entering blocks of data into a stepwise linear multiple regression (Astin & Dey, 2001; Avalos, Sax, & Astin, &, 1999).

Results of the dissertation are analyzed in Chapter 4. Chapter 5 includes an exploration of the themes presented in Chapter 4 to identify strategies for influencing college students' decisions to pursue STEM majors as their career choices is important to increase the number of people pursuing careers in science, technology, engineering, and mathematics. Recommendations defined in Chapter 5 provide a foundation for further research opportunities.

Chapter Four

Results

Chapter 4 presents the results of the data analyses used to provide a description of the sample and address the research questions and test the hypotheses developed for the study. The chapter is divided into three sections. The first section uses frequency distributions and measures of central tendency and dispersion to present participant profiles. The second section presents the scaled variables using descriptive statistics. The results of the stepwise multiple linear regression analysis used to test the hypotheses for the study are presented in the third section of the chapter.

The purpose of this study was to determine which factors (personal characteristics, family characteristics, self-appraisal, occupational information, goal selection, planning, and problem solving) influence college students to major in STEM disciplines. Identifying factors influencing college students' decisions to pursue STEM majors as their career choices is important to increase the number of people pursuing careers in science, technology, engineering, and mathematics. Figure 1 presents the conceptual model for the study.

The survey link to SurveyMonkey was sent to three organizations, Charles Drew Scholars Program, Michigan Lewis Stokes Alliance for Minority Participation, National Organization of Black Chemists and Black Chemical Engineers. The organizations put the link on their website and sent the link to students on their listservs. Each organization posted links for the survey to their respective members on the list serves three times. The criteria for an individual to appear on the list serve of each organization were (a) undergraduate students, (b) 18 to 25 years old, and (c) current member of a STEM

organization. A total of 4,521 potential participants entered the SurveyMonkey website and started the survey. After reviewing the responses and removing those not meeting the criteria for inclusion in the study, 178 participants were included in the data analysis.

Description of the Sample

The participants completed a detailed demographic section. Their personal characteristics, including age, gender, and ethnicity, were summarized using frequency distributions for presentation in Table 6.

Table 6

*Frequency Distributions: Personal Characteristics (*N *= 178)*

Personal Characteristics	Frequency	Percent
Age		
18	16	9.0
19	71	39.9
20	34	19.1
21	33	18.5
22	23	12.9
23	1	0.6
Gender		
Male	64	36.0
Female	114	64.0
Race/Ethnicity		
African American/Black	150	84.3
American Indian/Alaskan Native	1	0.6
Asian/Pacific Islander	4	2.2
Caucasian/White	3	1.7
Hispanic/Latino/Latina	7	3.9
Middle Eastern	7	3.9
Multi-ethnic	6	3.4

The students ranged in age from 18 to 23 years old. The largest group of participants ($n = 71$, 39.9%) reported their age as 19 years old, with 34 (19.1%) stating they were 20 years of age. Thirty-three (18.5%) participants were 21 years of age and 1

(0.6%) was 23. The majority of the participants (*n* = 114, 64.0%) reported their gender as female. The remaining 64 (36.0%) were male. Most of the participants (*n* = 150, 84.3%) were African American. The remaining 28 participants were from various ethnic groups.

The participants' provided their parents' educational levels and occupation types on the survey. Their responses were summarized using frequency distributions for presentation in Table 7.

Table 7

*Frequency Distributions: Parents' Educational Levels and Occupation Types (*N = 178)

Parents' Educational Levels and Occupation Types	Father		Mother	
	Frequency	Percent	Frequency	Percent
Educational Levels				
Less than high school	15	9.0	1	0.5
Some high school	8	4.8	3	1.6
High school graduate	74	44.6	26	14.1
Some college	32	19.3	57	31.0
Associate's degrees	9	5.4	27	14.7
Bachelor's degrees	16	9.7	43	23.4
Master's degrees	6	3.6	22	12.0
Doctoral degree	6	3.6	5	2.7
Missing	12		4	
Occupation Types				
Unemployed/Retired/Housewives	10	6.0	13	7.6
Service workers	2	1.2	3	1.7
Unskilled workers	13	7.8	7	4.1
Semiskilled workers	30	18.0	9	5.2
Skilled manual workers	55	32.8	24	14.0
Clerical and sales workers	4	2.4	26	15.1
Technicians/semiprofessionals	20	12.0	15	8.7
Small business owners/minor professionals	6	3.6	9	5.2
Administrators/lesser professionals	15	9.0	56	32.6
Executives/major professionals	12	7.2	10	5.8
Missing	11		6	

The highest number of fathers (n = 74, 44.6%) were high school graduates, with 16 (9.7%) reported completing a bachelor's degree. Fifteen (9.0%) fathers had less than a

high school education. Twelve participants did not respond to this question. Twenty-six (14.1%) mothers completed high school and 43 (23.4%) earned a bachelor's degree. Twenty-two (12.0%) mothers compared to 6 (3.6%) of fathers had master's degrees. Four participants did not provide their mother's education level on the survey.

Fifty-five (32.8%) of the fathers were skilled manual workers and 30 (18.9%) were semiskilled workers. Twenty (12.0%) fathers were employed as technicians or semiprofessionals. Eleven participants did not provide their father's occupation on the survey. Fifty-six (32.6%) mothers were working as administrators or lesser professionals and 26 (15.1%) were clerical and sales workers. Twenty-four (14.0%) mothers were working as skilled manual workers. Six participants did not provide their mother's occupation on the survey.

The participants were asked to provide family characteristics, including family composition, number of sisters, number of brothers, and annual family income on the survey. The responses were summarized using frequency distributions for presentation in Table 8.

71

Table 8

*Frequency Distributions: Family Characteristics (*N = 178)

Family Characteristics	Frequency	Percent
Family Composition		
Biological mother and father	78	44.6
Biological mother and stepfather	5	2.9
Biological father and stepmother	4	2.3
Mother only	80	45.6
Father only	4	2.3
Other relatives	1	0.6
Nonrelatives only	3	1.7
Missing 3		
Number of Sisters		
0	57	32.0
1 to 3	114	64.0
More than 3	7	4.0
Number of Brothers		
0	54	30.5
1 to 3	112	63.3
More than 3	11	6.2
Missing 1		
Annual Family Income		
Less than $20,000	18	10.6
$20,001 to $40,000	29	17.1
$40,001 to $60,000	50	29.4
$60,001 to $80,000	35	20.6
$80,001 to $100,000	16	9.4
More than $100,000	22	12.9
Missing 8		

The largest participant group (n = 80, 45.6%) reported they lived with their mother only, followed by living with a biological mother and father (n = 78, 44.6%). Other living arrangements included biological mother and stepfather (n = 5, 2.9%), biological father and stepmother (n = 4, 2.3%), father only (n = 4, 2.3%), other relatives (n = 1, 0.6%), and nonrelatives only (n = 3, 1.7%). Three participants did not respond to this question.

The majority of the participants (n = 114, 63.3%) had one to three sisters and 57 (30.5%) had no sisters. Seven participants had more than three sisters. The largest

participant group (n = 112, 63.3%) reported having 1 to 3 brothers, with 54 (30.5%) stated they had no brothers. Eleven (6.2%) participants had more than three brothers. One participant did not provide the number of brothers on the survey.

Eighteen (10.6%) participants stated their annual family income was less than $20,000, with 29 (17.1%) reporting an annual family income between $20,001 and $40,000. Fifty (29.4%) of the participants had annual family incomes between $40,001 and $60,000, and 35 (20.6%) had annual family incomes between $60,001 and $80,000. Family incomes between $80,001 and $100,000 were reported by 16 (9.4%) participants, with 22 (12.9%) stating annual family incomes greater than $100,000. Eight participants did not respond to this question.

The participants provided information about their high schools, including school type, location, and student body composition. The responses to these items were summarized using frequency distributions. Table 9 presents analysis results.

Table 9

*Frequency Distributions: High School Related Factors (*N = *178)*

High School Related Factors	Frequency	Percent
Type of high school		
Public	146	83.0
Private	30	17.0
Missing 2		
High school location		
Urban	117	66.9
Suburban	49	28.0
Rural	9	5.1
Missing 3		
Gender composition of high school		
Coed	147	85.4
All males	13	7.6
All females	12	7.0
Missing 6		

The majority of participants (n = 146, 83.0%) attended public schools and 30 (17.0%) had attended private schools. Two participants did not respond to this question. Most of participants attended schools in urban areas (n= 117, 66.9%), with 49 (28.0%) going to high school in a suburban area. Nine (5.1%) participants attended schools in rural areas. Three students did not respond to this question. The majority of the students (n = 147, 85.4%) attended coed high schools and 13 (7.6%) attended all male schools. Twelve students attended all female high schools. Six students did not respond to this question.

The students provided responses to added items about their high schools, including school size, number of students in their graduating classes, numbers of specialized coursework, their high school grade point average, and their ACT scores. High school grade point averages could exceed 4.0 because extra honor points are awarded for honors and advanced placement classes. The students could report ACT or SAT scores. Few students stated their SAT scores as more colleges and universities accept ACT scores. A conversion table was used to convert SAT scores to ACT scores if a student had completed only the SAT. The results of this analysis are presented in Table 10.

Table 10

*Descriptive Statistics: High School Demographics (*N = 178)

High School	N	M	SD	Median	Range Minimum	Maximum
Number of students in high school	173	1,541.64	843.76	1,500.00	128.00	4,000.00
Number of students in graduating class	178	349.42	209.78	304.00	14.00	1,500.00
Number if international baccalaureate courses	168	.56	1.48	0.00	0.00	12.00
Number of advanced placement courses	171	2.20	1.99	2.00	0.00	8.00
Number of honors classes	173	6.23	3.73	6.00	0.00	20.00
High school grade point average	177	3.55	.40	3.60	2.00	4.60
ACT score	178	23.00	3.89	23.00	13.00	32.00

The mean number of students in the high schools was 1,541.64 (SD = 843.76), with a median of 1,500.00. The number of students in the high schools ranged from 128 to 4,000. The number of students in the participants' graduating classes was 349.42 (SD = 209.78), with a median of 304.00 students. The range of students in the graduating classes was from 14.00 to 1,500.00. The students reported completing a mean of .56 (SD = 1.48) international baccalaureate (IB) classes with a median of 1.48 IB classes. The number of IB classes completed ranged from 0 to 12. The number of advanced placement classes ranged from 0 to 8 classes, with a median of 2.00 advanced placement classes. The mean number of advanced placement classes completed by the participants was 2.20 (SD = 1.99). The students completed an average of 6.23 (SD = 3.73) honors classes, with a median of 6.00 honors classes. The number of honors classes completed by the students ranged from 0 to 20 classes. The high school grade point averages ranged from 2.00 to 4.60, with a median of 3.60. The mean high school grade point average was 3.55 (SD =

75

.40). The students' ACT scores ranged from 13.00 to 32.00, with a median of 23.00. The mean ACT score was 23.00 (SD = 3.89).

The students were asked if they took part in any STEM-related clubs or organizations while in high school. The students could state all organizations they belonged, resulting in a higher number of responses than participants. Table 11 presents results of this analysis.

Table 11

Frequency Distributions: Membership in Clubs and Organizations in High School

Membership in Clubs and Organizations in High School	Frequency	Percent
Pre-engineering Club	100	56.2
Science Club	100	56.2
Science and Engineering Fair	90	50.6
Mathematics Club	88	49.4
Robotics Club	77	43.3
Computer Club	69	38.8
Medical Careers Club	28	15.7

One hundred (56.2%) participants stated they had been members of a pre-engineering club while in high school, with a similar number taking part in a science club. Ninety (50.6%) students took part in the science and engineering fair and 88 (49.4%) in the mathematics club. Seventy-seven (43.3%) participants were members of the robotics club and 69 (38.8%) were involved in a computer club. Twenty-eight (15.7%) students stated membership in medical careers club.

The students reported on college-related items. These items included current class standing, college credits completed, and highest academic goal. Item responses items were summarized using frequency distributions for presentation in Table 12.

Table 12

Frequency Distributions: College Related Factors (N = 178)

College Related Factors	Frequency	Percent
Class status		
Freshman	73	41.0
Sophomore	45	25.3
Junior	31	17.4
Senior	29	16.3
Number of college credits		
0 to 30	72	40.5
31 to 60	45	25.3
61 to 90	33	18.5
91 to 120	23	12.9
More than 120	5	2.8
Highest academic goal		
Nondegree	5	2.8
Certificate	1	0.6
Associate's degree	1	0.6
Bachelor's degree	85	48.3
Master's degree	18	10.2
Doctoral degree	49	27.8
Medical doctor	17	9.7
Missing 2		

The largest group of respondents (n = 73, 41.0%) reported their class status as freshman with 45 (25.3%) stating their class status was sophomore. Thirty-one (17.4%) participants stated their class status as junior and 29 (16.3%) were considered seniors. Seventy-two (40.5%) stated they had 0 to 30 credit hours, while 45 (25.3%) reported 31 to 60 credit hours. Thirty-three (18.5%) completed between 61 and 90 credit hours, while 23 (12.9%) completed between 91 and 120 credit hours. Five (2.8%) students had more than 120 credit hours. Most participants (n =85, 48.3%) had an academic goal of earning

77

a bachelor's degree, while 49 (27.8%) reported wanting to complete a doctoral degree.

Eighteen (10.2%) participants listed a master's degree as their highest academic goal and

17 (9.7%) listed becoming medical doctors. Two participants did not respond to this

question.

The participants were asked to respond to items about their majors. Their

responses were summarized using frequency distributions. Table 13 presents results of

this analysis.

Table 13

*Frequency Distributions: College Majors (*N = 178)

College Majors	Frequency	Percent
Current status in major		
Formally declared a major	161	93.1
Decided on a major, but not formally declared	8	4.6
Considering several majors	4	2.3
Missing 5		
Considering a STEM major		
Yes	143	96.6
No	5	3.4
Missing 30		
Type of STEM major		
Science	106	60.2
Technology	11	6.3
Engineering	51	29.0
Mathematics	6	3.4
Nonstem major	2	1.1
Missing 2		

The majority (n = 161, 93.1%) formally declared a major and eight (4.6%)

decided on a major, but not formally declared. Four (2.3%) were considering several

majors. Five students did not respond to this question. When asked if they were

considering a STEM major, 143 (96.6%) reported yes and 5 (3.4%) stated no. Thirty

78

participants did not respond to this question. Those participants who considered or formally declared a STEM major were asked to specify the STEM area. The majority of the participants (n = 106, 60.2%) stated science, followed by 51 (29.0%) in engineering. Eleven (6.3%) were interested in technology and six (3.4%) in mathematics. Two (1.1%) participants reported their major was nonSTEM. Two participants did not provide a response to this question.

The participants were asked to state colleges and organizations they belonged to in college. They were instructed to state all applicable colleges and organizations, which resulted in responses exceeding the participants. Table 14 presents results of this analysis.

Table 14

Frequency Distributions: Participants' Membership in Clubs and Organizations

Clubs and Organizations	Frequency	Percent
American Chemical Society	74	41.9
National Organization for the Professional Advancement of Black Chemists	70	39.3
National Society of Black Engineers	65	36.5
Louis Stokes Alliance for Minority Participation	52	29.2
Society of Women Engineers	46	25.8
Charles Drew Scholars Program	23	12.9
Biology Club	12	6.7
Institute of Electrical and Electronics Engineers	12	6.7
Computer Science Club	9	5.1
Society of Hispanic Professional Engineers	5	2.8
Mathematics Club	4	2.2
Gates Millennium Scholars Program	3	1.7
Mechanical Engineering Club	3	1.7
Civil Engineering Club	2	1.1
Society for the Advancement of Chicanos and Native Americans in Science	2	1.1
American Society of Civil Engineers – Student Chapter	0	0.0
Society of Physics Students	0	0.0

The largest group of participants (n = 74, 41.9%) were members of the American

Chemical Society, followed by the National Organization for the Professional

Advancement of Black Chemists (n = 70, 39.3%) and the National Society of Black

Engineers (n = 65, 36.5%). Fifty-two (29.2%) students were members of the Louis Stokes

Alliance for Minority Participants and 46 (25.8%) were participants in the Society of

Women Engineers. None of the students belonged to the Student Chapter of the

American Society of Civil Engineers and Society of Physics Students.

The students were asked to list STEM-related activities while in college. They were encouraged to list all activities of participation. Their responses were summarized using frequency distributions for presentation in Table 15.

Table 15

Frequency Distributions: Participation in STEM-related Activities in College

Participation in STEM-related Activities in College	Frequency	Percent
Membership in college/university STEM organizations	137	77.0
Participate in a mentoring program related to STEM	134	75.3
Volunteering in science-related activities	124	69.7
Membership in professional STEM organizations	116	65.2
Internships in major	84	47.2
Internships outside of major	71	39.9

The greatest number of students (n = 137, 77.0%) reported being members of college and university STEM organizations, with 134 (75.3%) reporting taking part in a mentoring program related to STEM. A total of 124 (69.7%) students volunteered in science-related activities and 116 (65.2%) had memberships in professional STEM organizations. Eighty-four (47.2%) students took part in internships in their major, while 71 (39.9%) had in internships outside their major.

The participants were asked if they took part in college organizations or college extracurricular activities not related to STEM. They were given a list of five different activities and organizations and instructed to check all applied. The results of the frequency distributions used to summarize the responses are presented in Table 16.

Table 16

Frequency Distributions: Memberships in Non-STEM Organizations or College Extracurricular Activities

Memberships in Non-Stem Organizations or College Extracurricular Activities	Frequency	Percent
Non-STEM student organization or club	147	82.6
Religious-affiliated student organization	65	36.5
College sports team	27	15.2
Fraternity or sorority	18	10.1
Band, choir, etc.	12	6.7

The largest group of participants (n = 147, 82.6%) reported they belonged to Non-STEM student organizations or clubs and 65 (36.5%) were members of religious-affiliated student organizations. Twenty-seven (16.2%) participants were on college sports teams, with 18 (10.1%) taking part in fraternities or sororities. Twelve (6.7%) students were in the band, choir or other activities.

Research Questions and Hypotheses

Six research questions were developed for this study. A stepwise multiple linear regression analysis using a blocked variable entry for each of the six steps was used to answer the six research questions.

RQ1. What influence, if any, do student demographic characteristics have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ2. What influence, if any, do major choice variables, have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ3. What influence, if any, do student-to-student interactions have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ4. What influence, if any, do faculty-to-student interactions have on career-decision-making self-efficacy?

RQ5: What influence, if any, do high school variables have on career-decision-making self-efficacy among undergraduate STEM majors?

RQ6: What influence, if any, do college variables have on career-decision-making self-efficacy among undergraduate STEM majors?

All decisions on the significance of the predictor variables were made using a criterion alpha level of .05.

A stepwise multiple linear regression analysis using a blocked variable entry format addressed the six research questions. The 51 independent variables for this study were divided into six blocks. The variables in each block were entered using the stepwise method of variable entry. Using a stepwise variable entry method allows only statistically significant variables to enter the stepwise multiple linear regression equation, but then re-evaluates each variable to determine if, at the end of the analyses, they remain statistically significant. Independent variables enter the regression equation if their p value is less than .05 and remain in the equation if the total p value for all statistically significant variables does not exceed .10.

Other variable entry methods were considered. The enter method forces all independent variables into the regression equation simultaneously, but does not allow for comparisons of changes in β-weights, p values, and r^2 among the independent variables. Forward and backward variable entry methods lacked the continuous assessment of the relationships between the dependent variable (career decision self-efficacy) and the independent variables. The decision was to use the stepwise variable entry method as it is

the most conservative and is the only method testing the independent variables at each step of the analysis.

Table 17 presents the results of the stepwise multiple regression equation. Nine of the 113 independent variables entered the stepwise multiple linear regression equation. The first column of the table identifies the variable, the second column provides the block it represents, and the third column is the zero-order correlation between the dependent variable (career decision-making self-efficacy) and the independent variable. The fourth column of the table shows the β-weight when the variable entered the stepwise multiple linear regression equation, with the fifth column providing the final β-weight. The sixth column lists the F ratio on the final step with the level of significance presented using one * for a p value of .05, ** for a p value of .01, and *** for a p value of .001.

Table 17

Significant Predictors of Career Decision-Making Self-Efficacy

Predictor Variable	Block	Zero r	Step β	Final Step β	F
Age	Personal characteristics	.52***	.52***	.41***	65.05***
Number of advanced placement courses	High school characteristics	.17***	.13*	.11	35.36***
Membership in professional STEM organizations	College characteristics	.28***	.17**	.14*	26.61***
Highest academic goal	College characteristics	.14	.15*	.11	21.79***
Number of hours/days spent studying in college	College Characteristics	-.01	-.13*	-.14*	18.63***
It is my passion	Choice variables	.45***	.34***	.21**	24.57***
Want to make a difference	Choice variables	.35***	.18**	.18**	22.77***
Encouraged by teacher/ guidance counselor	Choice variables	.30***	.16*	.13*	21.35***
Socialize with other students	Student to student interactions in STEM	.32***	.12*	.12*	19.98***

Note: n = 178, R^2 = .72, Adjusted R^2 = .49
*p < .05, **p < .01, ***p < .001

The nine predictor variables entered the stepwise multiple linear regression equation accounted for 72% (F = 19.98, p < .001) of the variance in career decision-making self-efficacy. These variables were entered in six steps to address the research questions.

The first block was the personal characteristics of the students in the sample. The variables were age, gender, and ethnicity. Age entered the stepwise multiple linear regression equation, with an initial β-weight of .56. At the final step, the β-weight decreased to .41.

85

The second block included the family characteristics, including parents'
educational levels, parents' occupation types, family composition, annual family income,
and number of siblings. None of the variables in this block entered the stepwise multiple
linear regression equation, indicating they were not statistically significant predictors of
career decision-making self-efficacy.

The students' responses on their high school variables were used in the third
block of the stepwise multiple linear regression analysis. The variables on this block
included ACT or SAT score, high school type, took international baccalaureate courses,
took advanced placement or honors courses, high school location, gender composition of
high school, number of students in graduating class, self-reported high school GPA,
hours daily spent studying in high school, and taking part in extracurricular activities in
high school. One variable, number of advanced placement courses entered the stepwise
multiple linear regression equation. The initial β-weight of .17 was reduced to .11 on the
final step. While this variable was statistically significant initially, it was no longer
statistically significant at the final step.

On the fourth block of the stepwise multiple linear regression analysis, college
variables, including credit hours completed, educational goals, and hours spent study in
college, current major, self-reported college GPA, attendance at a community college
before the Baccalaureate College, participation in STEM-related activities, and
membership in other types of college organizations. Three college variables, membership
in professional STEM organizations, highest academic goal, number of hours/days spent
studying in college entered the stepwise multiple linear regression equation on this block.
Membership in professional STEM organizations had an initial β-weight of .17, which

86

was reduced to .14 on the final step. The initial β-weight for highest academic goal was .14, which was reduced to .11 on the final step. Highest academic goal entered as a statistically significant predictor of career decision-making self-efficacy, but was not a statistically significant predictor on the final step of the analysis. Number of hours/days spent studying in college entered the stepwise multiple linear regression equation with an initial β-weight of -.13. On the final step, the β-weight increased to -.14.

The choice variables were entered into the stepwise multiple linear regression analysis on the fourth step. The choice variables drawn from the survey included reasons for choosing a STEM career. Three choice variables, it is my passion, want to make a difference, and encouraged by teacher/guidance counselor, entered the stepwise multiple linear regression equation. It is my passion had a β-weight of .34 on the first step, which decreased to .21 on the final step. Want to make a difference entered with a β-weight of .18, remaining constant at .18 on the final step. Encouraged by a teacher/guidance counselor had an initial β-weight of .16, which was decreased to .13 on the final step of the analysis.

Student-to-student interactions were included in the fifth block of the stepwise multiple linear regression analysis. These variables included studying with other students, tutoring other students, taking part in student organizations, socializing with other students, and using technology to communicate with other students. One of the student-to-student interactions, socialize with other students, entered with an initial β-weight of .12 and remained constant on the final step.

On the sixth block of the stepwise multiple linear regression analysis, faculty-student interaction variables were entered. These variables included communicate with

87

instructor by email, discussed grades or assignments with instructor, discussed career

plans with instructors, discussed ideas from readings with STEM instructors, and

received prompt feedback from instructors. None of the faculty-student interactions

entered the stepwise multiple linear regression equation, indicating they were not

statistically significant predictors of career decision-making self-efficacy. A summary of

the statistically significant findings for each of the research questions in this study are

presented in Table 18.

Table 18

Summary of the Findings for the Research Questions

Research Question	Significant Findings
RQ1. What influence, if any, do student demographic characteristics have on career-decision-making self-efficacy among undergraduate STEM majors?	Age (+)
RQ2. What influence, if any, do major choice variables, have on career-decision-making self-efficacy among undergraduate STEM majors?	It is my passion (+) Want to make a difference (+) Encouraged by a teacher/guidance counselor (+)
RQ3. What influence, if any, do student-to-student interactions have on career-decision-making self-efficacy among undergraduate STEM majors?	Socialize with other students (+)
RQ4. What influence, if any, do faculty-to-student interactions have on career-decision-making self-efficacy?	None
RQ5: What influence, if any, do high school variables have on career-decision-making self-efficacy among undergraduate STEM majors?	None
RQ6: What influence, if any, do college variables have on career-decision-making self-efficacy among undergraduate STEM majors?	Membership in professional STEM organizations (+) Number of hours/days spent studying in college (-)

Summary

The results of the data analyses used to describe the sample and address the research questions have been presented in this chapter. A total of 178 students from 18- to 23-years participated in this study. The majority of the participants were female and African American. Most of the parents had graduated from high school and were working as professionals. The greatest number of students were living with their mothers only and had siblings. The annual family incomes ranged from less than $20,000 to more than $100,000. The majority of students had attended public high schools in urban areas. Most had participated in advanced placement, international baccalaureate courses, and honors courses. The average ACT score was 23.00 (SD = 3.89). The students had been actively involved in STEM-related clubs and organizations both in high school and college. The students from all classes were represented in the study, although most were in their freshman year. The highest academic goals ranged from bachelor's degree through doctoral and medical doctor degrees. The majority had formally declared a major, with most choosing a STEM-related area. Six research questions and associated hypotheses were developed for the study. The aim of these questions was to determine which variables could predict career-decision making self-efficacy. The findings indicated age, membership in professional STEM organizations, it is my passion, number of days/hours spent studying in college, want to make a difference, encouraged by teacher/guidance counselor, and socialize with other students were statistically significant predictors of career decision-making self-efficacy. Chapter 5 presents a discussion of the findings and implications for practice. Chapter 5 begins with a study summary, a discussion of results and recommendations for future research.

Chapter Five

Conclusions, Implications, and Recommendations

Introduction

Chapter 4 presented the results of the statistical analyses used to address the research questions in the study. Chapter 5 presents a discussion of the findings and implications for theory and practice. Chapter 5 begins with a study summary, a discussion of results and recommendations for future research. The chapter ends with a final summary.

This quantitative study explored factors influencing college students to major in science, technology, engineering, and mathematics (STEM) disciplines. The results of this study provide an awareness of factors that are predictive of career decision-making self-efficacy for school administrators, teachers, counselors, and parents who interact with college students to encourage them to pursue STEM college majors. Because technology and science have become more important in the global economy, the need for scientists, engineers, and technology experts has increased.

Understanding factors contributing to students' decisions to remain in college can provide a basis for helping college administrators develop enrollment strategies to improve student recruitment and retention. According to Astin (1984), faculty involvement with students is important in keeping students enrolled. Some faculty members may have to change their instructional methods to include one-on-one involvement with students. Students who commute to campus may become involved with activities on campus, increasing their involvement.

90

Summary of Results

The study participants were undergraduate college students who planned to major in a STEM-related career. Most participants were between 18- and 20-years of age, female, and African American. The largest number of parents completed high school or some college. While some parents had upper-level management jobs, the highest numbers of fathers were skilled workers and mothers were in lower-level administrative positions. The largest number of students was living with their mother only, followed by living with both biological parents. The annual family incomes of the students ranged from less than $20,000 to more than $100,000, with most families in the $40,000 to $60,000 range. The majority of the students attended coed public high school in urban locations. The participants were involved in STEM-related clubs and organizations while in high school. The largest number of students in the study was in their freshman year and most listed earning a bachelor's degree as their educational goal. The majority of participants stated they formally declared a major, with many planning to major in a science field. Most students were involved in some type of professional or college clubs and organizations related to STEM-related fields.

The six research questions were addressed using a stepwise multiple linear regression analysis, with the independent variables entered in blocks. The dependent variable was career decision-making self-efficacy. The six blocks were (a) student demographic characteristics, (b) major choice variables, (c) student-to-student interactions, (d) faculty-to-student interactions, (e) high school variables, and (f) college variables.

91

The stepwise variable entry method was used allowing only statistically significant independent variables to enter the stepwise multiple linear regression equation, re-evaluating each variable at each step to determine if they remain statistically significant predictors. Independent variables continue to enter the regression equation if their p value is less than .05 and remain in the equation if the total p value for all significant variables does not excel .10.

Student Demographics Characteristics. The first research question explored the influence of student demographic characteristics on career-decision-making self-efficacy among undergraduate STEM majors. Student characteristics included age, gender, and ethnicity. Such factors were suggested by Astin (1993) to be predictive of college persistence. Age entered on the first step as a predictor of career decision-making self-efficacy. The positive relationship showed older students were more likely to have higher career decision-making self-efficacy than younger students.

Family Variables. The educational levels of the father and mother, occupational types of both parents, family composition, annual family income, and number of siblings were entered on the second step of the stepwise multiple linear regression analysis. None of the family variables was found to be statistically significant predictors of career decision-making self-efficacy.

Choice Variables. The second research question examined the influence of major choice variables on career-decision-making self-efficacy among undergraduate STEM majors. Thirteen items were included on the survey to determine reasons why students choose to major in STEM careers. Three survey items entered the stepwise multiple linear regression equation, "it is my passion," "want to make a difference," and

92

"encouraged by teacher/guidance counselor," as statistically significant predictors of career decision-making self-efficacy. The positive relationships between these three variables and career-decision making self-efficacy provided evidence that students who were passionate about science and technology and wanted to make a difference were more likely to have higher levels of career decision-making self-efficacy. Although no literature was found specifically addressing issues on students' desire to enter a STEM career, most students were aware of the shortage of STEM college graduates available to assume careers in engineering, science, and technology.

Student-to-Student Variables. The third research question examined the influence of student-to-student interactions on career-decision-making self-efficacy among undergraduate STEM majors. One variable measuring student-to-student interactions, "socialize with other students" entered the stepwise multiple linear regression equation, indicating that students who socialized with other students were more likely to have higher levels of career decision making self-efficacy. These results supported previous literature showing student-to-student interactions were important for college persistence and involvement. Research conducted by Astin (1993) found that college student-to-student interactions were predictive of positive outcomes for STEM majors. Pritchard and Wilson (2003) conducted a study on college student-student interactions and found partying, drinking, and memberships in a Greek-letter organization were negative predictors of college success. The findings from prior research may show the types of student-to-student interactions are important in determining their effects on college outcomes.

Faculty-to-Student Variables. The fourth research question explored the influence of faculty-to-student interactions have on career-decision-making self-efficacy. None of the faculty-to-student variables were significant predictors of career decision making self-efficacy. The present study did not support prior research that found students were influenced by faculty-student interaction. Pascarella and Terenzini (2005) conducted a study of the effects of faculty feedback on student-faculty interactions, and found minority college students were not prepared for the rigor for college work. A study by Cole (2008) examined the effects of faculty constructive criticism on students' GPA and education satisfaction. Cole (2008) found opportunities for faculty to improve minority students' academic success and educational satisfaction. A study of faculty's attempt to increase students' academic performance was conducted by Lundberg and Schreiner (2004). Their findings provided evidence that interacting with faculty was a statistically significant predictor of positive academic outcomes for all students, especially for students of color.

High School Variables. The fifth research question explored the influence of high school variables on career-decision-making self-efficacy among undergraduate STEM majors. The variables entered on this block included ACT or SAT score, high school type, taking international baccalaureate courses, taking advanced placement or honors courses, high school location, gender composition of high school, number of students in graduating class, self-reported high school GPA, hours spent daily studying in high school, and taking part in extracurricular activities in high school. One high school variable, number of advanced placement courses, entered the stepwise multiple linear

94

regression equation, indicating students who took advanced placement courses were more likely to have higher career decision-making self-efficacy.

College Variables. The sixth research question explored the influence of college variables on career-decision-making self-efficacy among undergraduate STEM majors. The college variables that were entered on the fourth step of the stepwise multiple linear regression analysis included number of credit hours completed, educational goals, number of hours spent studying in college, current major, self-reported college GPA, attendance at a community college before the baccalaureate college, taking part in STEM-related activities, and membership in other college organizations. Two college variables, membership in professional STEM organizations and number of days and hours studying in college entered the stepwise multiple linear regression equation. These two variables were related to career decision-making self-efficacy, providing evidence that students were members of professional STEM organizations and those who spent less time studying in college were more likely to have higher career decision-making self-efficacy. Whalen and Shelley (2010) found students majoring in STEM fields had higher ability levels as evidenced by higher GPAs and ACT scores.

Implications for Theory and Practice

Research on college students who are choosing to major in STEM careers is important in determining why the number of graduates who have expertise in science, mathematics, and technology continues to decrease. College students are expected to declare a major in their freshman year influencing their future career choices. Some students are prepared to make career decisions early, while others need time to explore options. Families, teachers, and peers can influence their choices and career plans. The

95

results of this study provided support for factors influencing career decision making related to STEM careers.

Astin (1993) conducted research on positive predictors influencing the academic success among undergraduate students. His study focused on students in residential colleges, placing importance on student involvement. At the present time, many students in colleges and universities are commuters and have little time to be involved in college life. Detwiler (2011), in conducting a study assessing factors influencing student academic success, found that students prepared for their classes by completing their reading assignments. These students had significantly higher GPAs than students who were not prepared for class. Awareness of these factors can help college faculty members identify struggling college students who may need added support to be successful in STEM courses. The findings of the study supported the theoretical framework driving this research.

Implications for Theory. Astin's (1991) Input-Environment-Output (IEO) model was used as the framework for this study. The demographic variable, age, entered the regression equation as a significant predictor of career decision-making self-efficacy. This variable provided support for the input portion of the data analysis framework. Students need time to develop their career choices, with older students more likely to have decided on career options. Younger students need to be able to explore possible careers within STEM before developing the self-confidence to make the correct decision. An environmental variables, socializing with other students, was a statistically significant predictor of career decision-making self-efficacy. This variable was associated with interacting with other students who were pursuing STEM majors. Bouncing ideas off

96

other students can help a young adult develop the confidence needed to perform well in the difficult science and mathematics courses required in STEM majors. Career decision-making self-efficacy was influenced by these variables showing the involvement theory was supported by the results of the present study. The outcome component of Astin's theory is unknown at this time, but could be the focus of further research on what careers that participants in the present study pursued after graduating from college.

Implications for Practice. The practice implications from this study's findings have both institutional and program components. Older students have more life experiences and may be more confident in career decisions affecting how to spend their lives. Some students wanted to be involved in some type of STEM career from an early age, showing it was their passion. The students wanted to make a difference understood the importance of science and technology on the future. One of the findings, encouraged by teacher or guidance counselor, provided support teachers in elementary, middle, and high school should recognize students who have an aptitude for science and mathematics. After identifying these students, they need to provide positive supports to encourage them to continue their studies and choose a career in a STEM-related field.

High schools should encourage students to take advanced placement courses to challenge them to excel in courses often considered difficult. By showing the students that they can be successful in science and/or mathematics courses, their self-efficacy regarding career choice in STEM areas could be enhanced. Programs, often as early as elementary and middle school that explore career options can be used to motivate students to pursue STEM careers. These programs should grow with the student and continue into high school. Students could participate in job shadowing and internships,

97

enroll in college enhancement programs, and interact with professionals in STEM who speak in their classes. Through these experiences, students can become interested in pursuing STEM majors in college.

Colleges and universities may find providing information to students on career possibilities in STEM-related careers is a way to increase enrollment in these fields. Professors and instructors, especially in STEM courses, should find ways to encourage interaction among students that can foster their interest in pursuing a STEM major. Colleges and universities should consider working with high schools to create programs to foster students' interest in STEM. Providing information about STEM at an early age could create awareness and desire to pursue careers in science and technology fields. These courses can be challenging, but support of professors could encourage students to achieve success in their fields. Colleges and universities need to assume responsibility for increasing enrollment in the sciences and technology to ensure the United States remains a leader in the global marketplace.

Colleges and universities can strengthen the self-efficacy of STEM students by increasing their exposure to STEM fields early in their academic career (Kuenzi, 2008). This can be done by (a) integrating STEM related activities into the social and academic environment, (b) connection with or a link to academic resources such as 24/7 online tutoring, on-campus tutoring and free workshops, (c) offering students internships in STEM related majors (d) helping students with STEM interest to create a clear goals with a practical plan of action during their matriculation, (e) regular interaction with African American and non-African American STEM professionals, and (f) holding campus activities promoting a stronger sense of racial identity to influence pursuit of degrees in

STEM majors. The United States needs more engineers and scientists and starting early may be an important strategy for encouraging children and adolescents to choose these careers.

Lessons Learned from the Study

When I began conducting research on this topic, I found most research on student retention was published in the 1970s and 1980s. Most of this research had been done with students who lived on campus, unlike many students in the study who commuted to their classes and had little involvement with college activities. With the introduction of open enrollment and acceptance of students at all ability levels, college students have become more heterogeneous in terms of socioeconomic status and race/ethnicity.

Lessons learned from the participants in my study. The students were successful in high school where most had completed advanced placement and honors courses. They had student membership in at least one of three professional STEM organizations. The students maintained at least a 3.0 in their college majors and interacted with other students in their cohorts. These students appeared to be highly motivated about their potential careers and wanted to make a difference. The interest in science and math began early in their educational careers and through encouragement from counselors and teachers, as well as their parents, their interest and drive to become scientists grew throughout high school and college.

Through my professional experiences as a high school and college-level instructor in science, I have become aware of students' lack of motivation to pursue science and mathematics as a career choice. Many students feel that the coursework is too hard and does not apply to real life. They do not want to expend the effort needed to master what

they think is difficult material. Their lack of interest may be related to an absence of exposure and experience to science and math in real life.

When investigating the results of my study, I was surprised to determine that many of the statistically significant predictor variables were intrinsic to the individual (it is my passion, want to make a difference, number of hours studying in college, number of advanced placement courses in high school). Many students who were passionate about their majors in STEM and wanted to make a difference in society. They were internally motivated to study and had completed advanced placement classes while in high school.

I found students who socialized with other students were more likely to have higher levels of career decision-making self-efficacy. These students could work in study groups to learn difficult material and interact with their peers regarding their career choices. Study groups and group assignments are excellent methods to provide support for struggling students and help them become successful.

An important lesson I am taking from this study is the need to have open discussions with my students on the far-ranging scope of careers related to STEM and the need to help them understand the relevance of science and mathematics in living in a rapidly changing society and the advent of new technology. In my research, I found the number of graduating seniors in college who were majoring in STEM and STEM-related subjects was not suitable to replace the retiring mathematicians, scientists, engineers. I am aware of the importance of getting students excited about STEM and encouraging them to pursue their passion in science and technology.

Teachers, professors, and parents are responsible for fostering their children's interests in STEM-related topics as early as possible. STEM topics, for example, should

100

be introduced in elementary students, when early learners are naturally curious and are developing essential cognitive skills. Instead of talking about how difficult science and math is, parents and teachers should discuss the importance of science and math and show how they are used in everyday life. By nurturing an interest in STEM-related fields, children can begin to develop career plans in science, math, technology, and engineering. This focus could students in developing and making career self-efficacy decisions at an early age.

What I would do different with my study if I was asked by other researchers. In conducting the present study, I thought that something was missing from the survey data. I would conduct a mixed methods study instead using both surveys and interviews to verify quantitative findings on career decision-making self-efficacy. The use of a survey with a large group of students provides useful information to determine factors that are predictive of career choices. The qualitative findings from semi-structured, face-to-face interviews with a selected group of students could underscore the importance of specific reasons students choose to major in STEM and then pursue careers in science, technology, engineering, and math.

The use of computer-based surveys is a data collection method that has the potential to develop a large sample size. The drawbacks of this type of survey unfortunately result in many false starts, premature leaving due to the length of the survey, and the inability of the researcher to be sure all participants met the criteria for inclusion in the study. In the present study, 844 potential participants started the survey, but only 178 had completed the surveys and met the criteria for inclusion in the study. Using pencil and paper surveys, in contrast, could ensure all participants met the criteria

for the study, although the time needed to input data before analyzing could be a constraint.

Limitations of the Study

The limitations of this study may affect the generalizability of the study. The first limitation is the length of the survey. A total of 844 students started the survey, but only 178 completed all portions and were included in the study. They may not have had sufficient time to complete the survey with their schedules. The instructions for the survey may not have been specific enough for the respondents.

The majority of students included in the study were African American (84.3%), although the survey was open to students of all races. The lack of representation among other racial/ethnic groups may limit the generalization beyond African American undergraduate college students.

The survey was intended for traditional college students, ages 18 to 25. Both younger students (age 17) and those who were older completed the survey and had to be removed from the study. The study was limited to undergraduate students, although some graduate-level students completed the survey. Their responses had to be removed from the sample.

Contribution to the Literature

The purpose of this study was to determine which factors (personal characteristics, family characteristics, self-appraisal, occupational information, goal selection, planning, and problem solving) influence college students to major in STEM disciplines. Identifying factors influencing college students' decisions to pursue STEM

102

majors as their career choices are important to increase the number of individuals pursuing careers in science, technology, engineering, and mathematics.

The United States has faced a political and social crisis because of the lack of students entering science, technology, engineering, and mathematics (STEM) fields. To meet the growing demand for a highly qualified scientific and technical workforce, research is needed to explore factors to influence students graduating from high school with sufficient mathematics and science preparation to pursue STEM or STEM-related college majors.

This study has contributed to the literature by using Astin's (1991) I-E-O model to predict performance on the career decision making self-efficacy scale. The present research found nine variables (age, advanced placement courses in STEM, membership in professional STEM organizations, highest academic goal, number of hours/days spent studying in college, it is my passion, want to make a difference, encouraged by teacher/guidance counselor, and socialized with other students) were significant predictors of career decision making self-efficacy.

While the input variables were important in choosing STEM major, the environment in Astin's (1991) study does not appear to be as important. When Astin was developing his I-E-O model, most college students were enrolled in residential colleges and universities. For the present study, more students may be living at home and commuting to a college or university. This difference may be important as colleges and universities need to find ways to encourage students to be more involved with campus life, including student clubs and organizations.

103

Recommendations for Future Research

While this study examined career decision making self-efficacy among undergraduate college students who expressed an interest in STEM, added research is needed to determine ways to encourage more students to complete college degrees in science, technology, engineering, and mathematics.

For STEM majors, the researcher recommends interpreting the total score used in the GSS study based directly on Bandura's self–efficacy theory. Scores in the GSS study are interpreted relative to prediction versus avoidance behavior. Participants in the GSS study with high self-efficacy or confidence scores predicted approach behavior, while low self-efficacy predicted avoidance behavior.

Research is needed to determine why students choose to major in a specific curricular area. This research could provide insight into why some students pursue majors in STEM and others choose to major in social sciences. Understanding their motivations could help counselors and advisors provide guidance with students who are having difficulty in choosing a major and future career.

The study could be replicated with a more heterogeneous sample, including representation from different ethnic groups. The present study used a sample with a majority of African American students. This study could compare demographic characteristics and reasons for pursuing STEM majors in college among the different ethnic groups.

A longitudinal study could be used to determine how interest in STEM careers emerges. Following middle school students through high school and into college can

104

provide data when interest in science and math changes, resulting in pursuing STEM majors or choosing the social sciences as a career option.

Conducting a study with people working in STEM careers could help determine what factors in high school and college were important in helping them decide to pursue careers in their fields. This type of study could be useful for K-12 and college administrators in helping their students become interested in STEM as possible careers. Further research using a qualitative case study research design is needed to examine why students choose to pursue STEM majors. While the present study found predictors of career decision-making self-efficacy, the reasons for pursuing a STEM major was not clear. By using a qualitative research design, in-depth, rich data could be obtained on reasons why students want to become scientists in a global society.

A study needs to be conducted to determine strategies that faculty members can use to encourage students to maintain their interest in STEM-related courses and careers. The present study found a positive relationship between student-to-student relationships and career decision-making self-efficacy. Faculty members need to encourage interactions among students that can help motivate them to discuss their interests in STEM.

A comparative study of several national STEM professional organizations with large college student membership needs to be conducted to determine the effect of membership on career decision-making self-efficacy.

A longitudinal study that follows middle school students through high school and college needs to be examined to determine when decisions regarding pursuing difference college majors begin to form. This type of study could help high school and college

105

counselors guide students into making appropriate decisions about types of majors to pursue to develop the skills and knowledge needed for STEM careers.

Conclusions

This study explored factors (personal characteristics, family characteristics, self-appraisal, occupational information, goal selection, planning, and problem solving) that influence college students to major in STEM disciplines. Understanding factors that influence college students' decisions to pursue STEM majors as their career choices is important to increase the number of people pursuing careers in science, technology, engineering, and mathematics.

This study can help educators in secondary and postsecondary institutions encourage students to commit to science and technology-related fields for their future careers. This study builds on Astin's (1984, 1999) involvement theory to determine its relevance in colleges and universities in the 21st century. Many students are not persisting in colleges and universities through graduation. College administrators need to understand which factors influence students' decisions to either remain in college or leave before completing their degree programs. As an increasing number of students commute to classes daily, at colleges and universities located in urban areas, comparing their personal and academic attributes to those adopted by Astin (1984, 1999) is an important method of deciding if their theories are still relevant.

This sample in this study included 178 students, ages 18 to 23; many were female and African American. Most of the participants' parents graduated from high school and were working professionals. The majority of students attended public high schools in urban areas, taking part in advanced placement, international baccalaureate courses, and

106

honors courses. The students were actively involved in STEM-related clubs and organizations in high school and college. The majority formally declared a major in a STEM-related area. The findings indicated age, father has a bachelor degree, annual family income, having a passion for science, understanding the country's need for college graduates in STEM, discussing ideas from reading with STEM instructors, discussing career plans with an instructor, taking advanced placement courses in STEM while in high school, and their cumulative college grade point average were statistically significant predictors of career decision-making self-efficacy.

Most participants wanted to earn a bachelor's degree, while nearly one-third of the participants reported wanting to complete a doctoral degree. Eighteen participants listed a master's degree as their highest academic goal. The majority of the participants stated their STEM major was science, followed by engineering, technology, mathematics. Most students reported being members of college and university STEM organizations, with 134 reporting taking part in mentoring programs related to STEM. A total of 124 students volunteered in science-related activities and 116 had memberships in professional STEM organizations. More than 80 students took part in internships in their major, while 71 had in internships outside their major. Counselors and college administrators have devoted substantial attention to the question how pre-college student's background characteristics influence the likelihood of them becoming STEM majors and working in STEM Careers.

Those professional organizations will want to take a leading role in nurturing the future STEM workers. The professional organizations will need to strategically commit the resources, energy, and attention to developing a broader range of students' affective,

cognitive, and relational talents and capabilities. Professional organizations that wish to play a positive role in developing tomorrow's STEM workers should strive to be conscious of the range of professional role models they introduce to their student members. These professional organizations need to understand the various types of cognitive and affective student development their organizations, knowingly or unknowingly, emphasize and reinforce. A disproportionate exposure to professional role models may make a negative impact on students' intentions toward those career paths associated with STEM career pathways, if not monitored closely.

The impact of the college environment on student outcomes has been the focus of research by many scholars in higher education and student development. This study has bridged the literature gap in those efforts and contributed to the literature by examining the influence of the college environment on the career decision-making self-efficacy of college students majoring in STEM. While the college and faculty need to foster their students' interests in STEM related majors, family variables and having a passion for science are also important. As the college students in this study matured, their career decision-making self-efficacy increases and they become committed to pursuing STEM-related careers.

College administrators should consider developing programs for incoming freshman to introduce them to the many career options available in science and science-related fields. This will encourage students who have not committed to a major to consider a STEM-related field. The findings have implications for the increasing number of students majoring in STEM at colleges and universities in the United States. As the world becomes increasingly competitive and technology continues to expand, developing

scientists, engineers, mathematicians, and medical field personnel who are ready to meet the challenge becomes more important. Future research is needed on this topic for colleges and universities who want to foster academic success for all students. Professional organizations can help with student development encouraging undergraduate research projects, peer mentoring, working with the professionals in the field, which will increase encouragement and participation among student members. Those organizations that are serious about encouraging today's students can help them become tomorrow's STEM workers.

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111

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121

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127

Goff's STEM Survey (GSS)

Welcome

ADULT RESEARCH SUBJECT - INFORMED CONSENT FORM
Influence of College on Student Science,
Technology, Engineering, and Mathematics
(STEM) Self-Efficacy

Principal Investigator: Dr. David Meabon, Committee Chair, 419-530-2666
George Goff, Doctoral Candidate, 313-212-9504
Purpose: You are invited to participate in a research project entitled "Influence of College on Student Science, Technology, Engineering, and Mathematics (STEM) Self-Efficacy," which is being conducted at the University of Toledo under the direction of Dr. David Meabon, Committee Chair. The purpose of this study is to identify which factors (e.g., personal characteristics, family characteristics, self-appraisal, occupational information, goal selection, planning, and problem solving) influence college students to major in STEM disciplines. Identifying factors that influence college students' decisions to pursue STEM majors is important to increase the number of individuals pursuing careers in science, technology, engineering, and mathematics.

Description of Procedures: Your portion of this research study will take place on your home computer, your office computer, or another computer of your choosing. You will be asked to complete a questionnaire using SurveyMonkey (an online data collection platform) that should take about 15 minutes to complete. The purpose of this questionnaire is to identify factors that have influenced you to choose your major in college.

Potential Risks: There are minimal risks to participation in this study, including loss of confidentiality. Responding to the questionnaire (i.e., participating in this study) might cause you to feel upset or anxious. If so, you may stop at any time.

Potential Benefits: The only direct benefit to you if you participate in this research may be that you will learn about how Internet surveys are conducted, and you may learn more about factors that influence students to choose a major. Others may benefit by learning about the results of this research.

Confidentiality: The researchers will make every effort to prevent anyone who is not on the research team from knowing that you provided this information or what that information is. The data you provide will not include your name or any identifiable information, and the data will be kept confidential. Although we will make every effort to protect your confidentiality, there is a low risk that this confidentiality might be breached.

Voluntary Participation: Your refusal to participate in this study will involve no penalty or loss of benefits to which you are otherwise entitled. In addition, you may discontinue participation at any time without any penalty or loss of benefits.

Contact Information: If you have any questions at any time before, during, or after your participation, or if you experience any physical or psychological distress as a result of this research, you should contact a member of the research team: Dr. David Meabon--419-530-2666, or George Goff--   .

If you have questions beyond those answered by the research team or questions about your rights as a research participant or research-related injuries, the Chairperson of the SBE Institutional Review Board may be contacted through the University of Toledo Office of Research on the main campus at (419) 530-2844.

Before you agree to participate in this study, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

1. SIGNATURE SECTION – Please read carefully

You are making a decision whether or not to participate in this research study. By selecting the "I have read the informed consent form, and I agree to participate in the study" button below, you are indicating that you understand the risks well enough to make a decision about your involvement. You also acknowledge that you understand and agree to the terms described above.

❏ I have read the informed consent form, and I agree to participate in the study.

❏ I do not agree to participate in the study

Instructions for completing the questionnaire:

Please respond to the following items as they apply to you. The responses to the items will be confidential. There are no right or wrong answers. The information obtained from this questionnaire will be presented in aggregate, and no individual will be identifiable in the final project. Feel free to skip any item with which you may be uncomfortable.

By participating in the study and completing the survey, you are eligible to be entered into a drawing for one of three $50.00 VISA gift cards. After completing the questionnaire, you will be provided an opportunity to enter you email address for the drawing.

Career Self-Efficacy Scale

2. What is your current class standing in college?

❏ Freshman
❏ Sophomore
❏ Junior
❏ Senior
❏ Graduate Student
❏ Other (please specify) _____

129

3. **Select the response that matches your confidence level with each of the following statements.**

1	2	3	4	5
No Confidence at all	Very Little Confidence	Moderate Confidence	Much Confidence	Complete Confidence

How much confidence do you have that you could:	1	2	3	4	5
1. Use the internet to find information about occupations that interest you.	1	2	3	4	5
2. Select one major from a list of potential majors you are considering.	1	2	3	4	5
3. Make a plan of your goals for the next five years.	1	2	3	4	5
4. Determine the steps to take if you are having academic trouble with an aspect of your chosen major.	1	2	3	4	5
5. Accurately assess your abilities.	1	2	3	4	5
6. Select one occupation from a list of potential occupations you are considering.	1	2	3	4	5
7. Determine the steps you need to take to complete your chosen major successfully.	1	2	3	4	5
8. Persistently work at your major or career goal even when you get frustrated.	1	2	3	4	5
9. Determine what your ideal job would be.	1	2	3	4	5
10. Find out the employment trends for an occupation in the next decade.	1	2	3	4	5
11. Choose a career that will fit your preferred lifestyle.	1	2	3	4	5
12. Prepare a good resume.	1	2	3	4	5
13. Change majors if you did not like your first choice.	1	2	3	4	5
14. Decide what you value most in an occupation.	1	2	3	4	5
15. Find out about the average yearly earnings of people in an occupation.	1	2	3	4	5
16. Make a career decision and then not worry whether it was right or wrong.	1	2	3	4	5
17. Change occupations if you are not satisfied with the one you enter.	1	2	3	4	5

1	2	3	4	5
No Confidence at all	Very Little Confidence	Moderate Confidence	Much Confidence	Complete Confidence

How much confidence do you have that you could:	1	2	3	4	5
18. Figure out what you are and are not ready to sacrifice to achieve your career goals.	1	2	3	4	5
19. Talk with a person already employed in a field you are interested in.	1	2	3	4	5
20. Choose a major or career that will fit your interests.	1	2	3	4	5
21. Identify employers, firms, and institutions relevant to your career possibilities.	1	2	3	4	5
22. Define the type of lifestyle you would like to live.	1	2	3	4	5
23. Find information about graduate or professional schools.	1	2	3	4	5
24. Successfully manage the job interview process.	1	2	3	4	5
25. Identify some reasonable major or career alternatives if you are unable to get your first choice.	1	2	3	4	5

Please mark the response that matches your confidence level with each of the following statements.

Why I Choose to Major in STEM

1	2	3	4	5
Least Important	Somewhat Important	Important	Very Important	Most Important

Circle the number that most closely matches the importance of each of the following items in deciding to choose a STEM major	1	2	3	4	5
1. Good starting salary out of college	1	2	3	4	5
2. STEM majors are intellectually stimulating/challenging	1	2	3	4	5
3. The job potential is good	1	2	3	4	5
4. It is my passion	1	2	3	4	5
5. I have always enjoyed games/toys/books about science	1	2	3	4	5
6. I enjoyed participating in clubs focused on STEM	1	2	3	4	5
7. I received good grades in science and math in high school	1	2	3	4	5

131

8. I want to make a difference	1	2	3	4	5
9. Our country is in need to college graduates who are focused on science and mathematics	1	2	3	4	5
10. A family member has similar education/career	1	2	3	4	5
11. I was encouraged by a teacher or guidance counselor	1	2	3	4	5
12. My parents told me I had to major in STEM	1	2	3	4	5
13. A mentor encouraged me to pursue STEM as a major	1	2	3	4	5
14. Other reason: (Specify)	1	2	3	4	5

To what extent have you participated in the following activities with other students (Circle the frequency with which you do each of these activities weekly)

	Never	Occasionally	Often	Daily
1. Studies with other students	0	1 to 3 times	4 to 6 times	
2. Tutor other students	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily
3. Participate in student organizations on campus	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily
4. Socialize with other students	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily

Use the following technology to communicate with other students:

	Never	Occasionally	Often	Daily
1. Email	0	1 to 3 times	4 to 6 times	
2. Text messages	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily
3. Social networks (e.g., Facebook, Twitter, Pinterest)	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily
4. Telephone	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily

132

To what extent have you participated in the following activities with other students (Circle the frequency with which you do each of these activities weekly)				
	Never 0	Occasionally 1 to 3 times	Often 4 to 6 times	Daily
5. Online Chat Rooms				

Please indicate how often during a typical semester that you interact with faculty outside of your STEM courses using the following methods of communication				
1. How often have you used e-mail to communicate with an instructor?	Never	Once	2 to 3 times	4 or more times
2. How often have you discussed grades or assignments with an instructor?	Never	Once	2 to 3 times	4 or more times
3. How often have you discussed career plans with an instructor?	Never	Once	2 to 3 times	4 or more times
4. How often have you discussed ideas from your readings or classes with instructors outside of class?	Never	Once	2 to 3 times	4 or more times
5. How often have you received prompt feedback (written or oral) from instructors on your performance?	Never	Once	2 to 3 times	4 or more times

Please indicate how often during a typical semester that you interact with faculty in your STEM courses using the following methods of communication				
6. How often have you used e-mail to communicate with an instructor?	Never	Once	2 to 3 times	4 or more times
7. How often have you discussed grades or assignments with an instructor?	Never	Once	2 to 3 times	4 or more times
8. How often have you discussed career plans with an instructor?	Never	Once	2 to 3 times	4 or more times
9. How often have you discussed ideas from your readings or classes with instructors outside of class?	Never	Once	2 to 3 times	4 or more times

10. How often have you received prompt feedback (written or oral) from instructors on your performance?   Never   Once   2 to 3 times   4 or more times

Demographic Information

Age

_____

Gender
❏ Male
❏ Female

Race/Ethnicity
❏ African American
❏ American Indian/Alaskan Native
❏ Asian/Pacific Islander
❏ Caucasian/White
❏ Hispanic
❏ Middle Eastern
❏ Multi-ethnic
❏ Other _____

How many college credits have you completed (Not counting your current semester)
❏ 0 to 30 credits
❏ 31 to 60 credits
❏ 61 to 90 credits
❏ 91 to 120 credits
❏ More than 120 _____

What is your highest academic goal? (Please check only one.)
❏ Non-degree
❏ Certificate
❏ Associate's degree
❏ Bachelor's degree
❏ Master's degree
❏ Doctoral degree
❏ Medical doctor

134

Please select the option that best describes your current status regarding your major.
- ❏ I have formally declared a major at my institution.
- ❏ I have decided on a major but have not formally declared it at my institution.
- ❏ I am considering several majors at this time.
- ❏ I am not sure what my major will be.
- ❏ I am not planning to declare a major.

If you have formally declared a major, which area below best characterizes your major?
- ❏ Science
- ❏ Technology
- ❏ Engineering
- ❏ Mathematics
- ❏ Non-STEM major

If you have not formally declared a major, are you considering a STEM (Science, Technology, Engineering, and Mathematics) major?
- ❏ Yes
- ❏ No

What is the highest level of education your mother and father have completed? (Please check only one for Father and only one for Mother.)

	Father	Mother
Less than high school	❏	❏
Some high school	❏	❏
High school graduate	❏	❏
Some college	❏	❏
Associate's degree	❏	❏
Bachelor's degree	❏	❏
Master's degree	❏	❏
Doctoral degree	❏	❏

What is your father's occupation (his job and not his place of employment – for example, "welder," "teacher," etc.)?

_____

What is your mother's occupation (his job and not his place of employment – for example, "administrator," "teacher," etc.)?

_____

135

What is your annual family income?

❏ Less than $20,000
❏ $20,001 to $40,000
❏ $40,001 to $60,000
❏ $60,001 to $80,000
❏ $80,001 to $100,000
❏ More than $100,000

What best describes your family's composition when you were between the ages of 11 to 18? (Please select only one option.)

❏ Biological mother and father
❏ Biological mother and stepfather
❏ Biological father and stepmother
❏ Biological mother and adoptive father
❏ Biological father and adoptive mother
❏ Adoptive mother and father
❏ Mother only
❏ Father only
❏ Grandparents only
❏ Other relatives
❏ Nonrelatives only

How many sisters do you have? Include half-sisters, step-sisters, and full biological sisters.)

_____

How many brothers do you have? Include half-brothers, step-brothers, and full biological brothers.)

_____

About how many students attended the high school from which you graduated?

_____

What kind of high school did you attend?

❏ Public
❏ Private

Where was your high school located?

❏ In an urban area (in an inner city or large metropolitan area)
❏ In an suburban area (in a community just outside of a large metropolitan area)
❏ In a rural area (in a farming community or small town)

What was the gender composition of your high school?
❏ Coed (both males and females)
❏ All males
❏ All females

Approximately how many students were in your graduating class?

_____

How many International Baccalaureate courses did you complete in high school, if any?

_____

How many Advanced Placement or Honors Classes did you complete in high school, if any?

_____

How many honors courses did you complete in high school, if any?

_____

If you answered yes to Item 30 or 31, please indicate whether any of these advance placement or honors courses were primarily associated with science, technology, engineering, or math (Please check only one).
❏ Science
❏ Technology
❏ Engineering
❏ Math

What was your cumulative high school GPA?
_____

Approximately how many hours a day did you spend studying in high school?

_____hours

Did you participate in any extracurricular activities in high school?
❏ Yes
❏ No

What was your ACT score?

_____

137

What was your SAT score?

_____

What is your current cumulative college GPA?

_____

Approximately how many hours a day do you spend studying in college?

_____hours

Please indicate whether you have participated in any of the following clubs or organizations while in COLLEGE (please check all that apply)
❏ American Chemical Society
❏ American Society of Civil Engineers Student Chapter
❏ Biology Club
❏ Charles Drew Scholars Program
❏ Civil Engineering Club
❏ Computer Science club
❏ Gates Millennium Scholars Program
❏ Institute of Electrical & Electronics Engineers
❏ Louis Stokes Alliance for Minority Participation
❏ Mathematics Club
❏ Mechanical Engineering Club
❏ National Organization of Black Chemists and Chemical Engineers
❏ National Society of Black Engineers
❏ Society for the Advancement of Chicanos and Native Americans in Science
❏ Society of Hispanic Professional Engineers
❏ Society of Women Engineers
❏ The Society of Physics Students

Please indicate whether you have participated in any of the following clubs or organizations while in HIGH SCHOOL (please check all that apply)
❏ Computer Club
❏ Mathematics Club
❏ Medical Careers Club
❏ Pre-Engineering Club
❏ Robotics Club
❏ Science Club
❏ Science and Engineering Fair

Please indicate whether you have participated in any of the following activities while in COLLEGE (Please check all that apply).

- ❏ Internships in your major
- ❏ Internships outside of your major
- ❏ Membership in professional STEM organizations
- ❏ Volunteering in science-related activities
- ❏ Membership in college/university STEM organizations
- ❏ Participate in a mentoring program related to STEM

Have you participated in any of the following college organizations or college extracurricular activities? (Please check all that apply.)

- ❏ Fraternity or sorority
- ❏ Band, choir, etc.
- ❏ College sports team
- ❏ Religious-affiliated student organization
- ❏ Non-STEM student organization or club

Did you attend one or more community colleges before attending your current college or university?

- ❏ Yes
- ❏ No

With which organization are you primarily affiliated?

- ❏ National Organization of Black Chemists and Black Chemical Engineers
- ❏ Michigan Louis Stokes Alliance for Minority Participation
- ❏ Charles Drew Scholars Program
- ❏ Other _____

Thank you for completing this questionnaire! If you would like to enter a drawing for one of three $50.00 VISA gift cards, please provide your email address.

_____