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KEEPING THE BEST AND BRIGHTEST:

WHY ARE AMERICAN STUDENTS SHUNNING

MATH AND SCIENCE MAJORS?

by

Kandi Lanette Duff

A dissertation

submitted in partial fulfillment

of the requirements for the degree of

Doctor of Education in the Graduate Department of

School Psychology and Educational Leadership

Idaho State University

Spring 2015

COMMITTEE APPROVAL

To the Graduate Faculty:

The members of the committee appointed to examine the dissertation of Kandi Lanette Duff find it satisfactory and recommend that it be accepted.

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HUMAN SUBJECTS COMMITTEE APPROVAL PAGE

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April 18, 2014

Kandi Duff
180 South 800 West
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RE: Your application dated 4/16/2014 regarding study number 4079: Keeping the Best and Brightest: Why Are American Students Shunning Math and Science Majors?

Dear Ms. Duff:

I agree that this study qualifies as exempt from review under the following guideline: 2. Anonymous surveys or interviews. This letter is your approval, please, keep this document in a safe place.

Notify the HSC of any adverse events. Serious, unexpected adverse events must be reported in writing within 10 business days.

You are granted permission to conduct your study effective immediately. The study is no subject to renewal.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Patricia Hunter (208-282-2179; fax 208-282-4529; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

DEDICATION

To my husband and best friend, Mike:

You have my deepest appreciation and all the expressions of love that I can muster for the support, encouragement, patience, and the sacrifices you made during this lifelong education process. You believed in me when I didn’t even believe in myself. For that, I will be eternally grateful. This degree is as much yours as mine for all the slack you have picked up, all the crazy wife moments you have had to put up with, and for being a great editor, critic, and cheerleader in this long process.

To my children, John, Grant, Madison, Peter, Susan, and Michael:

Each one of you has sacrificed by allowing me the time to pursue this goal. You have been my support and inspiration throughout my higher education endeavors. I thank you for your patience, understanding, and encouragement.

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ABSTRACT

The choice of academic major is one of the most important decisions an undergraduate student makes at a university. Many of the “best and brightest” math and science students in America are shunning Science, Technology, Engineering, and Math (STEM) majors. The point in the STEM pipeline where the highest losses occur is between high school graduation and college entry. The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho who complete a rigorous high school academic program to choose or not choose STEM majors in college.

This quantitative study surveyed Idaho 2010, 2011, and 2012 high school graduates from three public high schools. The survey sample consisted of academic honors students (3.6 g.p.a. or higher) who had completed at least one capstone course in math or science. This study examined demographics, math and science self-efficacy, decision factors influencing choice of a college STEM major, and capstone course completion to explain the choice of a college STEM major.

Findings reveal that math and science self-efficacy and math and science capstone course completion in anatomy and physiology, honors physics, AP calculus, trigonometry, or honors trigonometry had a statistically significant relationship with college STEM major choice. Additionally, the study revealed that respondents tended to finish in the college major (STEM or non-STEM) where they began. Respondents who were STEM majors changed their major but still remained STEM majors, while respondents who were non-STEM majors changed majors but remained non-STEM majors. Recommendations include more emphasis on capstone course completion as a way to inspire students to pursue STEM majors in college and motivate students to become involved in STEM disciplines. High school level activities designed to increase student self-efficacy in math and science should include more student involvement with science fairs, competitions, research, clubs, classes, and/or guest speakers. Outreach regarding STEM is necessary if an increase in interest in STEM at the high school, and subsequently the college level, is to occur.

CHAPTER I

Introduction

The choice of an academic major is one of the most important decisions an undergraduate student makes at a university. Choice of academic major influences the future courses students must take to complete a degree and has a profound effect on the career path that is pursued after graduation. This choice also affects the interactions with faculty and other students within the academic unit on the campus where students will take most of their courses. The relationship of college major to career field varies. Obviously, some career choices dictate that a specific undergraduate major is chosen.

Choice of a STEM (science, technology, engineering, and math) major will help students achieve a broad understanding of the scientific and mathematical foundations of the natural and human-made worlds (National Research Council, 2011). As societies become more technologically complex and as that complexity affects the natural world, the development of greater understanding of the natural and human-made worlds becomes increasingly important. There is a need locally, regionally, nationally, and worldwide for better prepared individuals in STEM areas (National Research Council, 2010).

Beginning in the 1960s, the percentage of college students choosing to major in STEM (science, technology, engineering, and math) fields began to decline. While the number of bachelor's degrees awarded annually has more than doubled in the last 40 years, the same cannot be said for the number of degrees awarded in STEM (National Center for Education Statistics, 2012). Since 1971 there has been a 4.3% decrease in the United States in the number of bachelor's degrees awarded in science, technology, engineering, and mathematics majors (National Science Foundation, 2012). Further, while the enrollment in STEM degree fields has increased, the percentage of undergraduate degrees awarded in STEM fields declined from 32% to 16% of all degrees awarded (Consortium of Social Science Associations (COSSA), 2008).

In the 1980s, the Higher Education Research Institute (HERI) at the University of California, Los Angeles (UCLA) studied the decline in the percentage of freshmen choosing to enter and remain in mathematics- and science-based majors. The findings were based on longitudinal surveys of large, national samples of freshmen at two- and four- year institutions. As principal investigators of these studies, Astin and Astin (1993) indicated that in the 1980s, science, mathematics, and engineering majors suffered a relative student loss rate of 40% between freshman and senior years. Loss rates ranged from 50% in the biological sciences and 40% in engineering to 20% in the physical sciences. Very few students transferred into science, technology, engineering, and math (STEM) majors after college enrollment.

Between 1986 and 2006, increases in entering college student interest in STEM fields have been observed (Hurtado, Chang, & Eagan, Jr., 2010). Although findings from recent analyses show that today more students from all backgrounds enter college with an interest in STEM, most of these students either complete degrees outside of STEM or drop out of the higher education system altogether (Hurtado et al., 2010). At larger institutions, students encounter a plethora of disciplines in which to major. These disciplines may include fields of which students were previously unaware and which may influence students to change their majors. Such experiences have led to some enrollment losses by competent students who might otherwise have remained in science, technology, engineering, and math (STEM) majors (Schwartz, 2004). More than 30 years later, after the first Cooperative Institutional Research Program (CIRP) survey was introduced to assess student completion rates among initial STEM majors, approximately the same proportion of students reported intentions to major in STEM, and the loss rates from STEM majors have remained stable (Hurtado et al., 2010).

Research conducted by Panteli, Stack, and Ramsay in 2001 highlighted the decline in the percentage of United States college students majoring in STEM disciplines. Of all the students who had entered college and obtained a bachelor’s degree in 2001, only 19% of bachelor’s degree recipients majored in science, technology, engineering, or mathematics (Carnevale, Smith, & Melton, 2011).

Capable STEM students from K-12 level all the way through the postgraduate level will be needed in the pipeline for careers that utilize STEM competencies and increase innovative capacities. The “STEM” report (Carnevale et al., 2011) from the Georgetown University Center on Education and the Workforce stated that the current “education system will need a stronger STEM curriculum at the high school and undergraduate level that is more tightly linked with competencies necessary for STEM careers” (p. 11). There is increasing demand for STEM talent, and the current educational system has, thus far, not adequately produced these individuals.

Rising concern about the state of education in science, technology, engineering, and mathematics has many stakeholders decrying a purported decline in both the

> quantity and quality of students pursuing STEM careers. Fears of increasing global competition compound the perception that there has been a drop in the supply of high-quality students moving up through the STEM pipeline in the United States. (Lowell, Salzman, Bernstein, & Henderson, 2009, p. 1)

Because of the need for the United States to continue to perform well against growing science and technology innovation in places like China and Europe, the federal government has stepped up efforts to review and reinvest in programs and policies related to undergraduate education in fields of science, technology, engineering, and mathematics. The National Science Foundation (NSF) and the National Institutes of Health (NIH) have sponsored a number of initiatives aimed at increasing undergraduate students' interest in studying STEM and improving STEM bachelor's degree completion rates (Hurtado et al., 2010).

The need to develop domestic STEM talent was emphasized in *Rising Above the Gathering Storm, Revisited*, a 2010 report from the National Research Council of the National Academies of Science. The report suggested that the United States needs to increase the number of students entering areas of national need, including doctoral degree levels in sciences and engineering. Since the enactment of the National Defense Education Act of 1958, the federal government has identified certain fields that are crucial to national innovation, competitiveness, and well-being and in which not enough students complete degrees. The four overarching recommendations to improve America's areas of national need (via 20 specific actions) can be summarized as follows: improve the United States K-12 education system in science and mathematics to a leading position by global standard; double the federal investment in basic research in mathematics, the physical sciences, and engineering; encourage more United States citizens to pursue careers in mathematics, science, and engineering; and, rebuild the competitive ecosystem by introducing reforms in the nation's tax, patent, immigration, and litigation policies (National Research Council, 2010).

Talented students need to be encouraged to enter STEM fields and then be retained as they progress through careers. This is especially true in fields that may be experiencing a decline in enrollment in the past decade, such as engineering and information technology. To encourage talented students to enter STEM fields, an understanding of the factors that attract talented individuals to STEM and influence their choice of college major is needed.

The course-taking behavior of high school students in science and mathematics has been a particular focus of educators, researchers, and professional counselors for several years (Trusty, 2002). Adelman (1999) related that students who completed more academically intensive course work in high school were more likely to graduate from college. The National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine produced a list of recommendations to improve and guide federal policy making in the 21st century (National Research Council, 2007). This effort resulted in several recommendations targeting education in the United States. At the K-12 level, recommendations focused on increasing the number of secondary education programs that prepare students to enter college and graduate in STEM disciplines.

A National Action Plan for Addressing the Critical Needs of the U. S. Science, Technology, Engineering, and Mathematics Education System (2007), released by the National Science Board, called for a common STEM curriculum across all grades and across all states. The National Science Board is also seeking greater coordination efforts among federal, state, and local agencies on research findings that will benefit STEM education.

High school course-taking and achievement in science is a national social and political issue. Goal 5 from the National Education Goals Panel (NEGP) brought together by President George H. W. Bush (National Education Goals Panel, 1999) addressed science and math in the United States. Of the four indicators given in Goal 5, three goals focused on increases in high school science achievement, and the fourth specified an increase in the number of students, including minority students and women, graduating from college with science degrees (National Education Goals Panel, 1999). Policymakers throughout the United States are currently contemplating strategies to prepare young adults for careers in STEM fields (National Research Council, 2010).

Although the United States has been a world leader in several indicators of scientific production (quantitative indicators of publication, information technology, and evaluation by peers), the gap between the United States and other countries is decreasing. For example, one of the indicators of scientific production reported by the National Science Board (2012) in its *Science and Engineering Indicators 2012* is the research article output in science and engineering. In 2009 the United States produced 20,597 more science and engineering articles than in 1999. In China, 58,304 more science and engineering articles were written in 2009 than in 1999. The United States growth rate for scientific research articles was 1%, while the world-wide average rate for scientific research articles grew 2.6% between 1999 and 2009. In the previous decade, the United States output of scientific research articles declined by 5%, while in Asia there were increases of 16.8% in China and 10.1% in South Korea. Very rapid annual growth rates over 10% between 1999 and 2009 were also seen in Iran, Thailand, Malaysia, Pakistan, and Tunisia (p. 13).

This nation was built on an innovative economy that harnessed the scientific and technological ingenuity that has long been at the core of America's prosperity (White House Press Briefings, 2012). If the current trends in STEM are left unchecked, this pattern becomes a problem for the United States in retaining its status as the world leader in science and technology. The Bureau of Labor Statistics projects that by the year 2022 the combination of new positions and retirements will lead to over 1.1 million openings in STEM career fields (Bureau of Labor Statistics, 2013). The outlook for filling these positions with homegrown talent is not promising. The 2007 National Research Council Report for the National Academy of Sciences, *Rising Above the Gathering Storm,* stated that the United States' position as a leader in innovation is at risk due to "a recurring pattern of abundant short-term thinking and insufficient long-term investment" (p. 13). The report stressed the need for and importance of developing domestic talent in science, technology, engineering, and math.

Many of the nation's most talented students in high school science, technology, engineering, and math courses are choosing not to pursue STEM majors in college or are leaving at some point in their college careers (National Science Board, 2012). In Idaho as well as across the nation, students are avoiding science, technology, engineering, and math from the high school level through college major choices and into careers. Identifying factors that indicate why recent high school graduates choose or not choose a

STEM major in college is at the core of understanding the STEM pipeline retention problem.

Statement of Problem

Although the decline of students in STEM majors is a problem for universities and industry, the point in the STEM pipeline where the highest losses occur is between high school graduation and college entry (National Center for Higher Education Management Systems, 2013). These losses in the STEM pipeline lead to a steady decline in freshman enrollments in undergraduate science majors. Teschler (2010) noted that students with math and science skills are choosing not to pursue STEM majors in college.

Only 49.1% of Idaho students graduating from high school continue directly to a college program (National Center for Higher Education Management Systems, 2013). This statistic places Idaho as the third lowest state in the nation in number of students continuing their education straight from high school. Fewer still are studying in fields related to STEM. Despite a growing national need to develop capabilities in science, technology, engineering, and math, only 17% of Idaho students continuing directly to a college program from high school go into STEM majors (Stone, 2010). According to former University of Idaho President, Duane Nellis, “Data support the lack of students tracking into STEM careers, and it’s more acute in Idaho” (Forester, 2010).

Many factors affect the college major choices of recent high school graduates. Identifying these factors would help parents, educators, and industry gain a better understanding of how a student’s ability to learn is influenced and what factors affect college major choice and, eventually, career choice.

Very little research has been done that has incorporated the factors that can contribute to a student's choice of a college STEM major. Although several studies have been conducted from varying viewpoints, none have synthesized all these viewpoints into an identifiable list of explanations. Studies have been done on STEM college major choice and self-efficacy (Bong & Skaalvik, 2003; Dunlap, 2005), academics (Levine & Zimmerman, 1995), SAT percentile rank (College Board, 2011), women and girls (American Association of University Women, 2008; American Physical Society, 2011; Bickenstaff, 2005), ethnicity (Riegle-Crumb & King, 2010), and high school science and math coursework (Tyson, Lee, Borman, & Hanson, 2007). However, no one study has attempted to analyze multiple factors and draw conclusions that may be useful in encouraging students to enter and stay in the STEM pipeline.

The specific studies that exist in college STEM major choice research clearly warrant a need to further explore, in a more comprehensive manner, the relationship between college STEM major selection and the influencing factors. This study incorporated many of the most common factors of college STEM major choice into one study and has attempted to add to the knowledge base in an original and interesting way.

Purpose Statement

The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho, who complete a rigorous high school academic program, to choose or not choose STEM majors in college.

Research Questions.

This study was guided by the following research questions:

1. What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?
2. What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?
3. What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

Definition of Terms

The following definitions were used to clarify terms in this study:

Academic honors. Students who attained a 3.6 or higher grade point average in high school and have completed at least two credits of Advanced Placement or honors coursework before high school graduation are considered Academic Honors students (Pocatello Chubbuck School District, 2012).

Advanced Placement (AP). Advanced Placement (AP) is a program created by the College Board that offers college-level curricula and examinations to high school students. The AP curricula for the various subjects are created for the College Board by a panel of experts and college-level educators in each subject. For a high school course to have the AP designation, the course must be audited by the College Board to confirm that it satisfies the AP curriculum (College Board, 2013).

Capstone course. A capstone course is an advanced course coming at the end of a sequence of courses with the specific objective of integrating a body of relatively fragmented knowledge into a unified whole (Durel, 1993). For the purpose of this study, capstone courses in math were delimited to trigonometry, honors trigonometry, honors college algebra, college algebra, calculus, honors calculus, AP calculus, and AP statistics. Capstone courses in science were delimited to AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, honors physics, and anatomy and physiology.

College major. A college major, also called an academic major, is the academic discipline that a student formally commits to completing. Completion of the course concentration requirements for a college major leads to an undergraduate degree (Idaho State University, 2012).

Idaho high school graduate. A high school graduate is an individual who earned at least the minimum number of credits required by the Idaho State Board of Education to graduate from an accredited high school and who received a diploma from one of the three high schools in the Idaho school district used in this study.

Honors coursework. Honors coursework or course is a common label applied to courses, predominantly at the high school level, that are considered to be more academically challenging and prestigious (Great Schools Partnership, 2013). For the purpose of this study, honors courses were delimited to science and math courses offered at all three high schools in this study.

Rigorous coursework. High school dual-credit, advanced placement, or honors coursework is considered rigorous coursework (Medhanie & Vanden Berk, 2013).

Self-efficacy. Self-efficacy is also called perceived ability. Self-efficacy refers to the confidence a person has in his or her ability to successfully perform a particular task. Self-efficacy is defined as a judgment of one’s ability to organize and execute the courses of action necessary to attain a specific goal (Bandura, 1997; Pajares, 2005; Zimmerman, 2000). “Researchers assess self-efficacy beliefs by asking individuals to report the level, generality, and strength of their confidence to accomplish a task or succeed in a certain situation” (Pajares, 1996, p. 546).

STEM. A nationally agreed upon definition for STEM is currently lacking. While the National Science Foundation uses a broader definition of STEM and STEM disciplines, which includes subjects in the fields of chemistry, computer and information technology science, engineering, geosciences, life sciences, mathematical sciences, physics and astronomy, social sciences, and STEM education, this study focuses on STEM defined as the physical sciences, biological sciences, technology, engineering, and mathematics and statistics. This study does not include social sciences and behavioral sciences in the definition of STEM. STEM disciplines are centered on relevant experiences, problem solving, and critical thinking processes and emphasize the natural interconnectedness of science, technology, engineering, and mathematics and their connection to other disciplines (National Science Foundation, 2012).

STEM pipeline. A metaphorical pipeline that progresses students from STEM courses in high school to STEM majors in a university or in college and ultimately to careers in science, technology, engineering, or math (Bickenstaff, 2005).

STEM-related. While STEM is defined as the academic and professional disciplines of mathematics, natural sciences, engineering, and computer and information sciences, STEM-related degrees are defined more broadly as a field of study with a focus on a STEM discipline (National Center for Educational Statistics, 2012).

Undergraduate student. An undergraduate student is an individual who has not attained his or her first bachelor’s degree and is enrolled in post-secondary education at a university. A student at the university entry level in the United States is known as an undergraduate (Idaho State University, 2012).

Limitations, Delimitations, Assumptions

Discussed below are the limitations, delimitations, and assumptions of this study.

Limitations. This study was limited by the following:

1. This study involved demographic differences (i.e., more of the honors students were female than male). According to the United States Census Bureau (2011), the sex composition of the United States is 49.2% male and 50.8% female, a composition ratio of 96.7. A composition ratio of 100 means that there are equal numbers of males and females. In the state of Idaho, the sex composition ratio is 100.4. Sex composition differences that are not representative of the general population could potentially skew results concerning gender differences and STEM college major choice.
2. Contacting recent graduates from the three subject schools proved to be difficult as some contact information was outdated. Response rates were lower than anticipated.
3. As a result of regional demographics, the study sample had many members of The Church of Jesus Christ of Latter-day Saints. This may have affected the survey response rate of the proposed study due to the practice of missionary service by Church members in the study participant age range.

Delimitations. This study was delimited by the following:

1. Study participants were delimited to individuals graduating from high school in May 2010, May 2011, and May 2012 from three high schools in a school district in southern Idaho.
2. Since the study schools are situated in a town where a university is located, an overrepresentation of children of university faculty among the potential participants may be a delimitation.
3. The potential participants were delimited to those individuals who attended college and were identified as graduating from high school with academic honors and having taken at least one capstone math or science course.
4. Capstone courses in math were delimited to calculus, honors calculus, AP calculus, college algebra, honors college algebra, AP statistics, trigonometry, and honors trigonometry. Capstone courses in science were delimited to anatomy and physiology, AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, and honors physics.
5. For the purpose of this research, capstone courses were delimited to science and math courses offered at all three high schools in this study.

Assumptions. This study was based on the following assumptions:

1. Respondents understood the survey questions and responded honestly.
2. Graduates who met the criteria of achieving high school academic honors and completing high school capstone course(s) were more likely to pursue post-secondary education and, therefore, choose a college major.

3. The capstone math and science courses contained similar information and course content and were presented similarly at all three high schools due to Idaho State Board of Education statewide standards.

Significance of Study

The results of this study have the potential to provide valuable insight into the decision factors that influence choice of STEM majors in college. This study will be significant to students, high school teachers, counselors, and administrators, higher education faculty and administrators, and employers in determining if changes in current practices are warranted to encourage students to select STEM majors in college.

The results of this study will have significance for students because of the potential to increase understanding of the decision factors that influence choice of STEM disciplines and careers. According to Borchert (2002), many students have not considered all the options for college major and career selection while in high school. Most students do not explore career possibilities until after graduation. According to the President's Council of Advisors on Science and Technology (PCAST) (White House, 2010), the fastest growing occupational categories in the United States economy are STEM disciplines. Recognition of the demand for people in science, technology, engineering, and math careers may result in students taking more STEM courses in high school and/or college and viewing STEM careers as a strong career choice leading to many career opportunities. This study may assist students in career planning and informed decision making about STEM courses, majors, and careers.

The study will potentially aid teachers, counselors, and administrators at the high school level to better prepare and inspire future generations of scientists and engineers by identifying opportunities for influencing choice of a college STEM major. Data garnered from this study may help teachers with course development and teaching strategies that encourage students to pursue post-secondary education in science, technology, engineering, and math.

High school counselors may benefit from this study by understanding the reasons students choose or choose not to enter the STEM pipeline. Counselors can encourage high school students' interest in a STEM major in college by advising students to take science and mathematics courses. This study may also be important to high school principals, since they ultimately partner with high school registrars and high school counselors to determine master schedules and course rotations.

The factors that influence the choice of undergraduate major will be of keen interest to universities and the faculty who teach there. For many years, colleges and universities in the United States have experienced decreases in enrollments in science, technology, engineering, and math majors (Heidel et al., 2011). Major selection is important to the faculty who teach classes in STEM disciplines and university administrators who fund such classes. Enrollments affect the number and timing of courses being offered, the staffing requirements of the departments that offer such courses, and, ultimately, the recruitment efforts of the various colleges within the university.

Employers are not immune to the effect of decline in enrollments in STEM majors. A shortage of applicants in STEM areas is complicated by the fact that a growing need for talent exists in these fields. It is anticipated that by 2022, 15 of the 20 fastest growing occupations will require additional science or mathematics preparation in order to meet job requirements (Bureau of Labor Statistics, 2013). This study may be important to employers as they search for ways to encourage individuals to enter STEM majors and careers.

Given the factors that may or may not exist that cause students to choose a college major, a student's sense of self-efficacy toward science, technology, engineering, and math, as well as other elements that may help keep students enrolled in the STEM pipeline, it becomes increasingly important to better understand why students choose or not choose a STEM college major. By so doing, stakeholders will be better able to not only inspire and better prepare future generations of scientists and engineers but also to provide for the technological and scientific future of our country.

Summary

This study is divided into five chapters. The first chapter, the introduction, outlines the research problem and the significance of the study. The second chapter, the literature review, examines existing STEM research in topics related to this study. The third chapter, the methodology, provides a detailed explanation of study methods and data collection. The fourth chapter, the results, presents the findings of the research study. The fifth chapter, the summary, discussion, conclusions, and recommendations, makes connections between the results of the study and the researcher's conclusions and recommendations for applications of the findings and for future research in the topic.

CHAPTER II

Literature Review

The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho, who complete a rigorous high school academic program, to choose or not choose STEM majors in college. This chapter examines the literature related to the following content areas: (a) history and trends nationally and statewide in regard to STEM enrollment in higher education, (b) high school preparation and its impact on college major selection, (c) science and math self-efficacy, and (d) factors that influence choice of college major. This chapter examines, at least in part, the transformation of STEM education from the 1700s to the present day, several career development theories that identify the reasoning behind high school course selection and college major choice, the role that math and science self-efficacy play in major selection, and the specific factors that are critical to college major choice.

History and Trends of STEM Enrollment in Higher Education

This section presents a review of the history of STEM education in America as well as STEM education enrollment and graduation rates, both historically and currently, in this nation and across the state of Idaho.

History of STEM education. Benjamin Rush, a Founding Father of the United States as well as the founder of Dickinson College in Carlisle, Pennsylvania, stated, “The business of education has acquired a new complexion by the independence of our country” (as quoted in Lucas, 1994, p. 113). The great majority of the Founding Fathers acquired their education through a rigorous classical and book-oriented method. The Founding Fathers read voraciously (Nash, 1989). “Most noteworthy about the Founding Fathers’ reading habits was their tendency to regard books not as ornaments but as tools. The Founding Fathers were readers, collectors, users, and creators of books” (Nash, 1989, p. 23). Thomas Jefferson and John Adams, two of the most intellectual of the Founding Fathers, took extraordinary efforts to create not just serviceable personal libraries but collections of exceptional quality (Nash, 1989).

Thomas Jefferson had a strong belief in the perfectibility of man – the idea that, given knowledge, men could govern themselves. In a letter to George Ticknor, Jefferson stated, “Knowledge is power . . . Knowledge is safety, and Knowledge is happiness” (as quoted in Edwards, 1976, p. 230). To provide that knowledge, Jefferson advocated systems of public schools and libraries that were regarded as visionary in his time (Dykeman & Stokely, 1968).

As part of his work in revising the laws of Virginia, Thomas Jefferson put forth a bill in 1780 that has become one of his most enduring works on the subject of education: Bill 79, "A Bill for the More General Diffusion of Knowledge.”

> Whereas it appeareth that however certain forms of government are better calculated than others to protect individuals in the free exercise of their natural rights, and are at the same time themselves better guarded against degeneracy, yet experience hath shewn, that even under the best forms, those entrusted with power have, in time, and by slow operations, perverted it into tyranny; and it is believed that the most effectual means of preventing this would be, to illuminate, as far as practicable, the minds of the people at large, and more especially to give them

> knowledge of those facts, which history exhibiteth, that, possessed thereby of the experience of other ages and countries, they may be enabled to know ambition under all its shapes, and prompt to exert their natural powers to defeat its purposes; And whereas it is generally true that that people will be happiest whose laws are best, and are best administered, and that laws will be wisely formed, and honestly administered, in proportion as those who form and administer them are wise and honest; whence it becomes expedient for promoting the publick happiness that those persons, whom nature hath endowed with genius and virtue, should be rendered by liberal education worthy to receive, and able to guard the sacred deposit of the rights and liberties of their fellow citizens, and that they should be called to that charge without regard to wealth, birth or other accidental condition or circumstance; but the indigence of the greater number disabling them from so educating, at their own expence, those of their children whom nature hath fitly formed and disposed to become useful instruments for the public, it is better that such should be sought for and educated at the common expence of all, than that the happiness of all should be confided to the weak or wicked. (as quoted in Boyd, Cullen, Catanzariti, & Oberg, 1950, pp. 526-7)

Bill 79, "A Bill for the More General Diffusion of Knowledge," proposed establishing the first public school system in America, and Jefferson called this bill "the most important bill in our whole code" (as quoted in Borden, 1963, p. 82). Jefferson wanted three levels of education reaching all classes, rich or poor. The first level would provide elementary schools for all children. The second level would provide colleges for the instruction of the common purposes of life. The third level would be an ultimate academy or college for teaching the sciences generally and also in their highest degree.

In 1800, Thomas Jefferson wrote to Pierre Samuel du Pont de Nemours, asking, “What are the branches of science which in the present state of man, and particularly with us, should be introduced into an academy?" (Jefferson, 1800). Du Pont proposed a plan of national education with primary schools, colleges, and four specialty schools: “medicine, mines, social science and legislation, and higher geometry and the sciences" (du Pont de Nemours, 1800, p. 1). With engineering "urging forward the other sciences, this school would be of the greatest benefit to the nation,” du Pont (1800, p. 1) explained.

Shortly after Jefferson's inauguration in 1802, Secretary of War Henry Dearborn announced that the President had decided in favor of the immediate establishment of a military school at West Point, New York (Coalwell, 2001). On March 16, 1802, Jefferson affixed his name to the Military Peace Establishment Act, directing that a corps of engineers be established and "stationed at West Point in the state of New York, and shall constitute a Military Academy" (Military Peace Establishment of the United States, 1802, Sec. 27). The academy's sole function would be to train engineers “to do duty in such places, and on such service, as the President of the United States shall direct” (Sec. 27). On July 4, 1802, the United States Military Academy formally opened for instruction. "Our guiding star," Superintendent Jonathan Williams said, "is not a little mathematical School, but a great national establishment. We must always have it in view that our Officers are to be men of Science, and as such will by their acquirements be entitled to the notice of learned societies" (as quoted in Coalwell, 2001, p. 2).

By 1802, when President Jefferson established the United States Military Academy, also known as West Point, he had fully embraced the importance of "useful sciences" in education and in the protection of the young nation (Coalwell, 2001, p. 2). Given his closely related interests in science, education, and republican government, Jefferson likely recognized that the military academy could serve several related purposes (McDonald, 2004). In this same period of time, helping to highlight the public value of an institution that could train scientists and engineers, expeditions such as the one led by Meriwether Lewis and William Clark were sent out.

By establishing engineering at West Point, Thomas Jefferson encouraged the beginning of STEM education in the United States. In a letter to John Adams in 1814, Jefferson stated, "I hope the necessity will, at length, be seen of establishing institutions here, as in Europe, where every branch of science, useful at this day, may be taught in its highest degree" (Lipscomb & Bergh, 1903-1904, p. 151).

Prior to the Civil War, the number of colleges and academies grew rapidly in the United States. The American college was evolving continuously in both form and content with interest in the sciences increasing rapidly (Lucas, 1994). John William Draper (1853) at New York University announced, “Mere literary acumen is becoming utterly powerless against profound scientific attainment” (p. 24). By the 1850s, if not before, according to Lucas (1994), botany, chemistry, and zoology had been added to a host of other applied scientific and technological arts in United States colleges. American higher education throughout the latter part of the nineteenth century was yielding to the demand to “incorporate more science, technology, nonclassical languages, and other modern subjects” (Lucas, 1994, p. 146).

The Morrill Land Grant Act of 1862 and the Agricultural College Act of 1890 changed the face of American higher education. These acts set the tone for the development of American universities, both public and private, for most of the following 100 years (Kerr, 2001). With the Morrill Acts, development of new scientific and technological knowledge became increasingly possible (Lucas, 1994). The Morrill Acts, originally intended to establish colleges and universities to study agriculture, the mechanical arts, and military tactics, also supported science and engineering programs, leading indirectly to the establishment of the university research system (Butz et al., 2004). Jonathan Baldwin Turner, an early advocate for agricultural and mechanical colleges, declared that land grant colleges established by the Morrill Acts of 1862 and 1890 offered the industrial classes “the same facilities to understand the true philosophy, the science, and the art of their several pursuits . . . and efficiently applying existing knowledge thereto and widening its domain, which the professional classes have long enjoyed in their pursuits” (as quoted in Foerster, 1937, pp. 24-25).

The first four decades of the twentieth century witnessed a flurry of curricular experimentation and reform in American higher education. One of the greatest impacts on the universities began with federal support of scientific research during World War II (Kerr, 2001). The major universities were involved in national defense and in scientific and technological development as had never before been experienced. During World War II, universities participated heavily in various war training and research programs (Lucas, 1994).

In 1940, before America officially entered World War II, attention was brought to the United States Congress that the civilian effort supporting the expected conflict would require far more engineers than were then available or could be supplied through normal programs at colleges and universities (Cardozier, 1993). Congress was prompted to implement the first war training program. The Engineering Defense Training (EDT) program was established within the Office of Education by the First Supplemental Civil Functions Appropriation Act of 1941, to provide engineering training for employees and prospective employees of industries. EDT was later named the Engineering, Science, Management, and Defense Training (ESMDT) program. ESMDT was expanded to include chemistry, physics, and production supervision training in 1941 (Records of the Office of Education, 1870-1983).

The ESMDT program was officially terminated in 1942, six months after the Japanese attack on Pearl Harbor. Its successor was called Engineering, Science, and Management War Training (ESMWT). According to Austin M. Patterson of the United States Office of Education (1942), “The new program will be of the same nature in all important respects as the previous one; the four fields of training, for engineers, chemists, physicists, and production supervisors, remain the same” (p. 1108).

The ESMWT program was one of the largest education projects in American history. Sometimes ESMWT was referred to as an "experiment in streamlined higher education” (Cardozier, 1993, p. 178). The government-sponsored program provided, without charge, college-level courses for large numbers of Americans needed to fill civilian technical and scientific positions during World War II (Cardozier, 1993). The war training programs were operated by the United States Office of Education from October 1940 through June 1945 for 1,800,000 students enrolled in 68,000 courses at 227 colleges and universities (Cardozier, 1993).

Scientific advances made during the war effort, such as the development of atomic weapons, arose from scientific research at universities. It has been estimated that in the 30 years after World War II, nearly half of the national growth was explained by scientific advances and by better technology, which were largely products of the educational system that was transformed by the war effort (Denison, 1962; Kerr, 2001). This increase in knowledge and innovation in the scientific and technological fields caused an explosion in the need for science, math, and engineering skills (Kerr, 2001).

The launch of Sputnik on October 4, 1957, the first artificial earth satellite, began an era that showed what an intelligent and purposeful policy aimed at producing a generation of productive scientists could do (Cremin, 1961). The United States needed to make changes in public education in order to counteract the seemingly superior Soviet school system that focused on training young scientists and to create an “elite generation” of our own pipeline of STEM workers (Passow, 1957). The United States reaction to the launch of Sputnik, coupled with ongoing criticism of the American educational system, set the stage for an unprecedented infusion of funding from the federal government to reform public education at all levels. This reaction spurred the United States Congress to pass the National Defense Education Act in 1958 (National Defense Education Act, 1958).

The majority of the National Defense Education Act funding was intended for those academically capable students (particularly in STEM areas) who did not have the financial ability to pursue undergraduate or graduate degrees (Fleming, 1960). According to Cremin (1961), all the obvious elements to produce the next generation of scientists were in place: a system for screening the student population to bring the talented to the forefront, serious enrichment programs aimed at high school students, college scholarship programs that took a particular interest in scientific talent, strong financial support for graduate students in science, and generous support of universities attempting to build their science programs into research departments. Overall, the NDEA impacted the educational landscape with more rigorous science and mathematics courses along with greater opportunity to explore STEM careers (Flattau et. al., 2006, p. VII–1).

The 1960s experienced a flurry of scientific innovation as the United States rushed to compete with the Soviet Union in space, which ultimately led to a landing on the moon. Breakthroughs in science were made in the 1970s with the development of the oral contraceptive (the pill), the first working laser, the beginnings of the Internet, the first human-to-human heart transplant, the introduction of successful in vitro fertilization (test tube babies), pictures of other planets sent from the Mars Viking probes, and the announcement by the World Health Organization that smallpox had been eradicated worldwide (Council for the Advancement of Science Writing, 2010). However, funding and interest in STEM education began to diminish in the 1970s as the Civil Rights Movement changed the focus to underserved populations, including racial minorities and those needing special education services (Delisle, 1999).

In Project 2061, the American Association for the Advancement of Science (AAAS) laid out a goal for what science education should look like by the return of Halley's Comet in 2061. “Project 2061: Science for All Americans” began its work in 1985, calling for widespread, long-term science education reform. AAAS promoted the idea that science education should help students become scientifically literate by integrating the disciplines of science, mathematics, engineering, and technology (SMET) to focus on themes and principles that unify the disciplines and clearly teach the nature of science (American Association for the Advancement of Science (AAAS), 2013). Project 2061 was the beginning of the scientific literacy reform movement that characterized the late 1980s and 1990s. From these projects, national standards and state core curricula were developed (AAAS, 2013).

In the 1990s, the National Science Foundation began using “SMET” as shorthand for science, mathematics, engineering, and technology. When a National Science Foundation assistant program director of the education and human resources directorate, Dr. Judith Ramaley, complained that the “SMET” acronym sounded too much like “smut,” the STEM acronym was coined. Dr. Ramaley stated:

> I did so because science and math support the other two disciplines and because STEM sounds nicer than SMET. The older term subtly implies that science and math came first or were better. The newer term suggests a meaningful connection among them (as quoted in Chute, 2009, paragraph 5).

From the beginning of STEM education in 1802 to the present, advances as the result of the focus on STEM have had a profound and widespread effect on all of society. Most of the major achievements associated with science, technology, engineering, and math are so much a part of life that they are taken for granted. Some of the greatest achievements include electrification of the United States and the invention of the automobile and airplane, electronics, radio and television, computers, the telephone, air conditioning and refrigeration, highways, spacecraft, the Internet, magnetic resonance imaging (MRI), household appliances, laser and fiber optics, nuclear technologies, and high-performanc materials (Constable & Somerville, 2003).

Far more powerful, however, than the achievements shared among STEM education fields is the rapidly emerging awareness in the United States that STEM education is not just a component of contemporary culture but also one critical to global competitiveness (Sanders, 2008). Amid the realization that STEM and STEM education will play a critical role in the 21st century, STEM enrollment in high school and colleges and universities has been identified as an important factor in America's quest to remain globally competitive.

Trends in STEM enrollment. Having looked at the history of STEM education in the United States, it is useful to look at the issues surrounding enrollment in STEM majors in higher education to better understand trends in choice of major nationally and in Idaho.

National STEM enrollment trends. "Science and technology have been powerful engines of prosperity in the United States since World War II but, currently science, technology, and mathematics education as well as the capability of the American workforce are in decline" (Hussain & Robinson, 2011, p. 1). In 2007, the United States ranked 17th among developed nations in producing science and engineering students, a decline from third place three decades earlier, and was 26th in producing mathematics majors. By 2007, the United States was producing 200,000 fewer STEM graduates per year than were needed (National Research Council, 2007).

> We can readily forecast continued demand for STEM workers, although the robustness of that demand is still unknown, which suggests that fewer students pursuing STEM careers could well create potential supply bottlenecks. America's

> competiveness in tomorrow’s knowledge economies might be sorely tested. (Lowell et al., 2009, p. 1)

Over the decades, students initially reporting ambitions to major in STEM-related disciplines in United States colleges and universities have been relatively easy to track because of instruments developed by the Cooperative Institutional Research Program (CIRP) at the Higher Education Research Institute (HERI) at the University of California, Los Angeles. College student STEM degree completion rates show that only 38% of students who entered STEM bachelor’s degree programs in the 1993-1994 academic year earned a STEM degree (Center for Institutional Data Exchange and Analysis, 2000). Freshman STEM degree candidates in 2004 had a degree completion rate of 16.9% four years later while non-STEM degree candidates had a four-year degree completion rate of 61.3%; this figure increased to 73.5% after five years (Hurtado, et al., 2010). Students who start out planning to major in STEM fields graduate in STEM fields at far lower rates than do their non-STEM classmates. Of the nearly 52 million college-educated persons represented in the 2010 National Survey of College Graduates (NSCG), only 28% reported their highest degree to be in a science and engineering (S&E) field (National Center for Science and Engineering Statistics (NCSES), 2013).

The percentage of bachelor's degrees conferred in science, technology, engineering, and mathematics fields in the United States was lower in 2008–09 (24.2 percent) than it was in 1998–99 (25.6 percent) (National Center for Educational Statistics, 2012). The data from the National Center for Educational Statistics (2012) in Table 1 display the bachelor’s degree graduation rates at public universities by state for the entire university population and for STEM degrees.

Table 1

Bachelor's Degree Graduation Rates from Public Universities by State: 2008-2010

State	Ranking	Grad. Rate (6 year)	Grad. Rate (4 year)	STEM Grad. Rate
Delaware	1	70.8%	54.8%	22.5%
Iowa	2	69.4%	39.6%	20.3%
Washington	3	68.9%	41.1%	23.3%
Virginia	4	68.4%	49.1%	24.2%
New Jersey	5	66.5%	40.1%	21.3%
New Hampshire	6	65.4%	46.6%	19.3%
California	7	65.1%	34.8%	23.0%
Vermont	8	62.9%	46.1%	23.3%
Illinois	9	62.5%	40.2%	22.7%
Maryland	10	62.3%	43.2%	25.7%
Pennsylvania	11	62.1%	39.7%	26.7%
Connecticut	12	61.5%	40.6%	21.0%
Florida	13	61.4%	35.4%	22.7%
Michigan	14	60.7%	32.8%	27.5%
Wisconsin	15	60.4%	27.4%	27.1%
North Carolina	16	59.1%	35.1%	25.0%
South Carolina	17	59.1%	38.8%	22.8%
New York	18	58.1%	37.8%	21.3%
Rhode Island	19	57.8%	34.1%	19.6%
Arizona	20	57.1%	31.9%	24.3%
Massachusetts	21	56.4%	35.4%	23.2%
Minnesota	22	56.4%	30.6%	23.8%
Nebraska	23	55.7%	23.2%	26.3%
Missouri	24	54.5%	29.6%	25.0%
Kansas	25	54.3%	26.2%	25.3%
Oregon	26	54.25	29.8%	24.8%
Colorado	27	53.3%	31.6%	26.2%
Wyoming	28	53.0%	22.5%	33.8%
Ohio	29	52.9%	30.3%	25.6%
Georgia	30	51.6%	24.0%	23.5%
Mississippi	31	49.9%	26.0%	24.3%
Indiana	32	49.7%	27.8%	26.2%
Texas	33	49.0%	24.4%	23.6%
Maine	34	48.5%	28.9%	31.2%
North Dakota	35	48.1%	14.0%	32.5%
Alabama	36	47.5%	22.9%	26.3%
West Virginia	37	47.4%	24.7%	25.0%

Table 1 (continued)

Bachelor's Degree Graduation Rates from Public Universities by State: 2008-2010

Hawaii	38	47.3%	16.3%	22.4%
Utah	39	46.9%	20.0%	25.8%
South Dakota	40	46.7%	20.4%	38.6%
Kentucky	41	46.6%	22.1%	22.6%
Tennessee	42	45.5%	19.7%	23.0%
Oklahoma	43	45.4%	21.5%	24.7%
Nevada	44	43.6%	13.5%	21.4%
Montana	45	42.7%	18.0%	31.7%
New Mexico	46	40.6%	11.9%	25.1%
Louisiana	47	38.8%	15.5%	27.0%
Arkansas	48	38.7%	19.7%	27.4%
Idaho	49	37.8%	14.0%	27.1%
Alaska	50	26.6%	8.2%	29.8%
District of Columbia	51	7.7%	2.4%	17.7%

Note: Adapted from "Digest of Education Statistics" (Table 286. Bachelor's degrees conferred by degree-granting institutions, by field of study: Selected years, 1970-71 through 2010-11), by National Center for Education Statistics, Institute of Education Sciences, 2012. Copyright 2012 by the National Center for Education Statistics.

The degree fields chosen by native-born and foreign-born college graduates differ significantly. Native-born United States citizens comprise 86% of the college-educated population residing in the United States (NCSES, 2013). Given the large size of the native-born population, the distribution of fields in which their highest degrees were earned is very similar to that of the overall college-educated population: 72% earn non-science and engineering degrees (NCSES, 2013).

Foreign-born college graduates (including naturalized United States citizens and non-United States citizens) are more likely to hold STEM and STEM-related degrees. Among the 7.2 million college-educated persons in the United States who are foreign-born, 42% hold STEM degrees and another 17% hold STEM-related degrees (NCSES, 2013). While the National Science Foundation (NSF) defines STEM more broadly to include life sciences and behavioral sciences, this study focuses more narrowly on STEM as the academic and professional disciplines of mathematics, natural sciences, engineering, and computer and information sciences, while STEM-related degrees are defined more broadly as a field of study with a focus on a STEM discipline (National Center for Educational Statistics, 2012).

"The demand for STEM talent is expanding beyond the walls of Google, IBM and Apple and STEM skills are needed in all industries," Mike Steinerd, director of recruiting at Indeed, said. "We live in an ever-evolving digital world, which is causing a shift towards technology in industries that aren't actually technology based like hospitality, music, and healthcare" (as quoted in Smith, 2013, p. 1). Steinerd concluded:

> Considering the anticipated increase in STEM-related jobs, a skilled workforce in science, technology, engineering and math will be the lynchpin to our country's success globally. Companies today, both small and large, stand to benefit significantly from the fast-growing information-based economy and globalization in general. However, the ability to identify, attract and retain STEM professionals will be essential to realizing these benefits. (Smith, 2013, p. 1)

Recognizing the critical importance of science and technology to America's long-term competitiveness, President George W. Bush, in his State of the Union Address on January 31, 2006, proposed the "American Competitiveness Initiative," a long-term approach to keeping America strong and secure by ensuring that the United States leads the world in science and technology (Domestic Policy Council, 2006). As a more permanent focus on science and technology, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (America COMPETES) Act of 2007, authorized various programs intended to strengthen research and education in the United States related to science, technology, engineering, and mathematics (America COMPETES, 2007).

President Barack Obama has signed the congressional reauthorization of the America COMPETES Act each year since taking office. He stated:

> COMPETES keeps America on a path of leadership in an ever more competitive world. It authorizes the continued growth of the budgets of three key agencies that are incubating and generating the breakthroughs of tomorrow, the Department of Energy's Office of Science, the laboratories of the National Institute of Standards and Technology, and the National Science Foundation. COMPETES also bolsters this Administration's already groundbreaking activities to enhance STEM education to raise American students from the middle to the top of the pack and to make sure we are training the next generation of innovative thinkers and doers. (White House Press Briefings, 2012, para. 3)

Congress passed the America COMPETES Act of 2007 with the overall goal of investing in research and development to improve United States competitiveness. The act also authorized investments in education in STEM fields. In 2011, the President signed the America COMPETES Reauthorization Act of 2010 (America COMPETES 2010). America COMPETES 2010 mandated that the United States Government Accountability Office (GAO) evaluate the status of programs authorized under the act, including the extent to which those programs have been funded and implemented and are contributing to achieving the goals of the act.

Together, these acts authorized $62.2 billion in funding from fiscal year 2008 through 2012. For fiscal year 2013, America COMPETES 2010 authorized an additional $16 billion, bringing the total amount authorized under the acts to $78.2 billion. Both America COMPETES 2007 and America COMPETES 2010 authorized the entire budgets of three previously existing federal research entities: National Science Foundation, Department of Energy’s Office of Science, and the Department of Commerce’s National Institute of Standards and Technology, including all programs within these entities. In addition, the acts specifically authorized funding for 40 individual programs, including some programs within and some outside these agencies (GAO, 2013).

Efforts to evaluate the effectiveness of investments in scientific research and STEM education in improving United States competitiveness (the overall goal of the America COMPETES Acts) is complicated by a number of factors. Evaluations of investments in scientific research and STEM education “face inherent challenges, such as those related to the long-term nature of many scientific research projects, an inability to predict certain outcomes, and difficulty tying specific investments to direct outcomes” (GAO, 2013, p. 8). According to the GAO (2013), for the fully implemented programs for which the America COMPETES Acts specifically authorized funding, recent evaluations generally reported positive results, and some evaluations provided suggestions for improvements. The GAO additionally found that overall appropriations have increased and have mainly funded existing federal research entities.

Developing a sufficient supply of STEM workers requires an understanding of how to develop flows of students into and through the STEM pipeline (Lowell, et al., 2009). The understanding of how this takes place is not well developed and has resulted in the pursuit of various programs, policies, and reform goals intended to improve both quality of and access to STEM education (Seymour, 2002).

Idaho STEM enrollment trends. According to the National Center for Higher Education Management Systems (2012), the number of Idaho high school graduates enrolling in college is increasing. In 2012, Idaho had an enrollment rate of 49.1%, an increase of 12% since 1998. The data show that this increase has been attributed, in part, to the “Go On Idaho” campaign, an initiative by the J. A. and Kathryn Albertson Foundation to boost enrollment in post-secondary education and training opportunities in the state (J. A. & Kathryn Albertson Foundation, 2013).

The data in Table 2 were derived from information supplied by the United States Department of Education, National Center for Education Statistics, Common Core of Data (CCD) (National Center for Education Statistics, 2012). Idaho has consistently had a graduation rate from public high schools of 81%, which is higher than the national average of 78.2%.

Table 2

Public High School Graduates and Graduation Rate by Region and State: School Years 2009-2010 through 2011-2012.

Region & State	2009–10	Grad. Rate	2010–11	Grad. Rate	2011–12	Grad. Rate
United States	**3,068,550**	**83.6%**	**3,103,540**	**78.1%**	**3,100,510**	**78.2%**
Northeast	**558,750**		**560,500**		**554,690**	
Connecticut	38,120	91%	38,450	83%	37,100	85%
Delaware	8,050	87%	8,190	78%	8,520	80%
Dist. of Columbia	3,150	76%	3,260	59%	3,250	59%
Maine	13,970	82%	14,030	84%	13,570	85%
Massachusetts	64,040	82%	63,820	83%	64,210	85%
New Hampshire	14,830	85%	14,300	86%	14,310	86%
New Jersey	96,510	95%	95,200	83%	94,280	86%
New York	182,880	76%	185,930	77%	185,910	77%
Pennsylvania	131,250	91%	132,100	83%	128,430	84%
Rhode Island	10,090	76%	9,880	77%	10,020	77%
Vermont	7,070	87%	6,790	87%	6,860	88%
Midwest	**707,880**		**702,540**		**698,810**	
Illinois	132,200	88%	132,670	84%	136,650	82%
Indiana	63,830	84%	65,460	86%	65,490	86%
Iowa	34,580	89%	33,710	88%	33,500	89%
Kansas	31,630	80%	31,320	83%	31,600	85%
Michigan	113,820	76%	110,300	74%	107,020	76%
Minnesota	60,400	92%	59,720	77%	58,770	78%
Missouri	63,640	86%	62,470	81%	62,310	86%
Nebraska	19,640	89%	19,620	86%	19,750	88%
North Dakota	7,160	88%	7,110	86%	7,000	87%
Ohio	107,900	84%	108,010	80%	105,130	81%
South Dakota	8,240	89%	8,550	83%	8,400	83%
Wisconsin	64,840	90%	63,600	87%	63,190	88%
South	**1,087,000**		**1,108,150**		**1,111,310**	
Alabama	43,110	88%	44,520	72%	44,570	75%
Arkansas	28,650	85%	28,440	81%	28,520	84%
Florida	158,070	78%	163,620	71%	159,450	75%
Georgia	89,730	81%	92,160	61%	90,130	70%
Kentucky	41,310	76%	41,930	75%	40,950	78%
Louisiana	34,790	67%	34,450	71%	34,700	72%
Maryland	58,560	87%	57,900	83%	58,760	84%
Mississippi	26,260	73%	26,930	75%	26,610	75%
North Carolina	84,900	74%	87,370	78%	90,280	80%

Table 2 (continued)

Public High School Graduates and Graduation Rate by Region and State: School Years 2009-2010 through 2011-2012.

Oklahoma	38,510	78%	38,120	78%	38,170	77%
South Carolina	39,560	72%	39,880	74%	40,480	75%
Tennessee	61,500	89%	62,520	86%	61,470	87%
Texas	273,050	84%	279,970	86%	285,530	88%
Virginia	80,270	80%	81,600	82%	82,770	83%
West Virginia	17,540	84%	17,300	78%	17,150	79%
West	**714,920**		**732,350**		**735,710**	
Alaska	7,820	68%	7,720	68%	7,750	70%
Arizona	64,800	78%	66,490	78%	64,670	76%
California	375,070	81%	386,220	76%	390,270	78%
Colorado	49,780	72%	51,820	74%	52,580	75%
Hawaii	10,860	80%	11,070	80%	11,150	82%
Idaho	17,280	81%	17,390	81%	17,150	81%
Montana	9,910	86%	9,690	81%	9,560	86%
Nevada	22,190	70%	24,990	62%	25,790	63%
New Mexico	18,660	67%	19,080	67%	19,080	65%
Oregon	35,300	85%	35,410	68%	34,780	68%
Utah	31,280	90%	30,340	76%	30,590	80%
Washington	66,470	83%	66,580	76%	66,720	77%
Wyoming	5,510	80%	5,570	80%	5,630	79%

Note: Adapted from "Digest of Education Statistics," by National Center for Education Statistics, Institute of Education Sciences, 2012. Copyright 2012 by the National Center for Education Statistics.

However, Figure 1 displays that the college-going rate of Idaho students is lower than the United States average. Data displayed in Table 2, Figure 1, and Table 3 indicate that only one of every four students who begin high school in Idaho will finish a bachelor's degree. The data shows that of the 81% of the students who graduate from high school, only 49.1% of those graduates go on to college. Of the 49.1% who do go on to college, approximately 20% complete degrees.

Figure 1. College Going Rate of Recent United States High School Graduates Compared to Idaho High School Graduates: 1992-2010

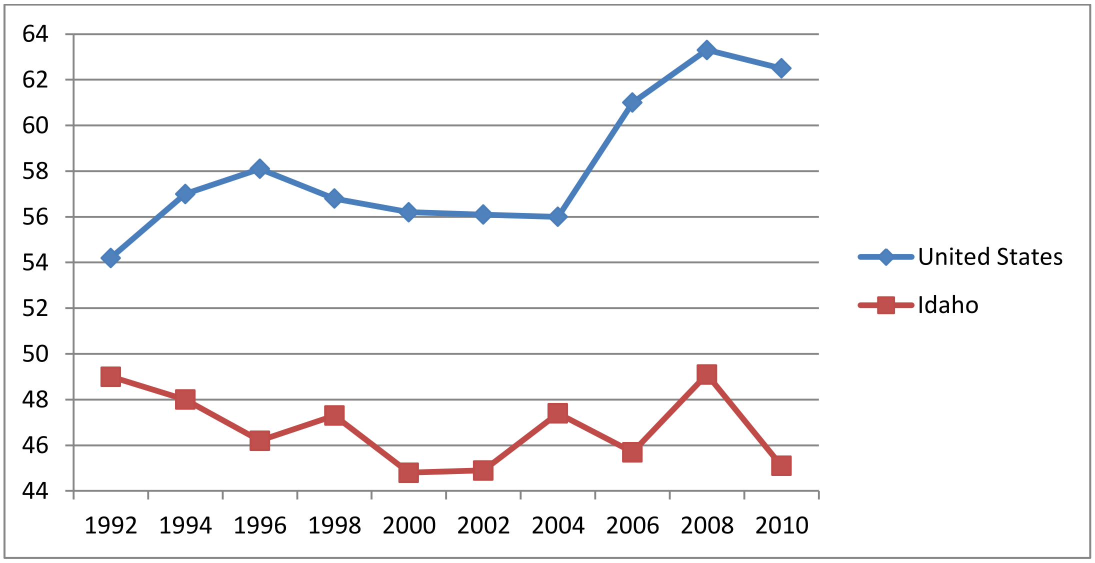


Figure1. Adapted from "Projections of High School Graduates, 2012," by B. T. Prescott and P. Bransberger, 2012. Copyright 2012 by Western Interstate Commission for Higher Education.

Table 3

Idaho 4-Year Public College Comparisons: 2008-2011

College	Graduation Rate (6 year)	Graduation Rate (4 year)
Boise State University	28.1%	6.5%
Idaho State University	25.7%	8.2%
Lewis-Clark State College	28.7%	15.9%
University of Idaho	55.1%	23.9%

Adapted from "Science and Engineering Indicators, 2012," by National Science Board, 2012. Copyright 2012 by National Science Board.

Though the number of students in Idaho going on to higher education has increased, the number of students in Idaho entering STEM majors is still low. The *Science and Engineering Indicators, 2012*, showed that of all the higher education degrees awarded in the state of Idaho, only 25.9% were in STEM. Advanced degrees in

STEM made up 16.3% of the degrees awarded, with doctoral degrees in STEM accounting for 2.6% of the advanced degrees (National Science Board, 2012). This means that in Idaho, only 9.6% of all higher education degrees were awarded in STEM at the bachelor's degree level.

Summary. From the first airplane flight to computers, innovations through the decades are because of individuals involved with STEM. Beginning in 1802 at the United States Military Academy until today, STEM education has played an important role in capturing the excitement, imagination, vision, and tenacity that ultimately made each scientific, technological, engineering, and mathematical achievement a reality.

The literature confirms a considerable surge in the need for STEM education in the United States and Idaho. The seeming urgency surrounding STEM and STEM education was addressed by Thomas Friedman in his popular book, *The World Is Flat*. Friedman (2005) quoted Shirley Ann Jackson, the president of the American Association for the Advancement of Science, who summarized America's anxiety about its place in the emerging world economy:

> The U.S. is still the leading engine for innovation in the world. It has the best graduate programs, the best scientific infrastructure, and the capital markets to exploit it. But there is a quiet crisis in U.S. science and technology that we have to wake up to. The U.S. today is in a truly global environment, and those competitor countries are not only wide awake, they are running a marathon while we are running sprints. If left unchecked, this could challenge our preeminence and capacity to innovate. (p. 253)

College Major Selection

Over the last several decades, researchers and theorists have identified abilities and behaviors underlying or related to the choice of college major and career. The body of literature for review of this topic is extensive. Therefore, the focus of this section will be limited to the five major career development theories that have directed career counseling, guidance, and research in the United States in the past few decades and the effect of high school course taking on a college major choice.

Career development theories. Making career decisions is anything but a static process. Career decision making is a lifelong process that everyone experiences over and over again (Hansen, 1976). All theories of career development and career choice emphasize the influences of abilities, achievements, and skills.

Holland's theory of vocational personalities in the work environment. John Holland created his theory of vocational personalities based on his work as a vocational counselor. In 1959 the focus of his research was on the task of searching for compatibility between personality and environment. Since 1959, Holland's theory has changed through his own research and that of other scholars. Concepts that have been added include subtypes and identity (Holland, 1992).

Holland's theory suggests a connection between career interests and typologies within a vocational context. Holland postulated that individuals fit into six typologies that represent interests and personality; Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C) (Holland, 1992). These six typologies describe the personality of a person as well as the environment for a profession.

Holland's research established that satisfaction and stability occur for an individual when the personality matches the environment; this match is called congruency.

Academic advisors and counselors often use Holland's theory in career and major exploration. An inventory, such as the Strong Interest Inventory (SII), is part of the exploration process. The test was developed in 1927 by psychologist E. Strong, Jr. to help people exiting the military find suitable jobs. It was revised later by Jo-Ida Hansen and David Campbell. The modern version is based on Holland's typologies (Peyser, 2002) and is designed for high school students, college students, and adults. The SII assists the individual with identification of his or her degree of resemblance to Holland's six personality and interest typologies based on interests and values. It also offers information on careers that are compatible with the individual's personality.

Self-concept theory of career development. As with just about any other area of human behavior, counselors and psychologists have developed several theories in an attempt to explain what happens during the career decision-making process. One of the most universally accepted theories of career decision making was developed by Dr. Donald Super, whose theory of career and life development was one of the first to describe career decision making as a developmental process that spans one's entire lifetime. Super (1969) stated that the degree to which an individual's career development is successful depends on how well that person is able to identify and implement her or his career self-concept. According to Super (1969), an individual's career self-concept is directly influenced by personality, abilities, interests, experiences, and values. Additionally, individuals progress through stages and developmental tasks over the life span. The stages Super (1969) identified are growth, exploratory, establishment, maintenance, and decline. It is the exploratory stage between the ages of 15 and 24 when individuals "try out" tentative choices in college and career choices through classes, work experience, and hobbies (Super, 1969).

Theory of work adjustment. The Theory of Work Adjustment (TWA) describes the relationship of the individual to his or her work environment. TWA was developed in two phases during the 1960s and 1970s as the guiding framework for a program of research in vocational psychology. During the 1960s, Rene V. Dawis and Lloyd H. Lofquist, University of Minnesota psychologists, formulated a trait-and-factor matching model and, in collaboration with David J. Weiss, developed instruments to measure the major constructs introduced by the theory (Tinsley& Eggerth, 2008). Dawis and Lofquist (1984) defined work adjustment as a “continuous and dynamic process by which a worker seeks to achieve and maintain correspondence with a work environment” (p. 237). This correspondence is the reciprocal process between the worker’s satisfaction and the employer’s satisfactoriness (Eggerth, 2008). Satisfaction is defined as being satisfied with the work one does while satisfactoriness is the employer’s satisfaction with the individual’s performance. Dawis and Lofquist state that “satisfaction is a key indicator of work adjustment” (1984, p. 217).

The Theory of Work Adjustment, as presented in *A Psychological Theory of Work Adjustment: An Individual-Differences Model and Its Applications* (1984) by René V. Dawis and Lloyd H. Lofquist, lists achievement, comfort, status, altruism, safety, and autonomy as the six key values that an individual seeks to satisfy through his or her work. Dawis and Lofquist (1984) stated that achievement is a condition that encourages accomplishment and progress, comfort is work conditions that encourage lack of stress, status is a condition that provides recognition and prestige, altruism is a condition that fosters harmony and service to others, safety is the condition that establishes predictability and stability, and autonomy is the condition that increases personal control and initiative.

The degrees of satisfaction and satisfactoriness are seen as predictors of the likelihood that someone will stay in a job, be successful at it, and receive advancement. The theory acknowledges that the correspondence between person and environment may not be perfect because the person may choose the wrong career or the employer may choose the wrong candidate. Even a good correspondence may change over time. The person's skills might develop so that he or she outgrows his or her role or his or her priorities may change because of non-work commitments.

Gottfredson's theory of circumscription and compromise. Gottfredson's theory of career development (1981, 1996, 2002, 2005) assumes that career choice is a process requiring a higher level of cognitive aptitude. A child's ability to synthesize and organize complicated occupational information is a function of progression due to chronological age as well as general intelligence. Intellectual growth and development are instrumental to the development of thought and interest in occupational alternatives. "Circumscription is the process by which youngsters . . . progressively eliminate unacceptable alternatives in order to carve out a social space (their zone of acceptable alternatives)" (Godfredson, 2002, p. 92). "Compromise is the process by which youngsters begin to relinquish their most preferred alternatives for less compatible ones that they perceive as more accessible" (Godfredson, 2002, p. 93).

In recent revisions of the theory, Gottfredson (2002, 2005) elaborated on the vibrant relationship between genetic makeup and the environment. Genetic traits play a crucial role in influencing the basic characteristics of an individual, such as interests, skills, and values; yet their expression is moderated by the individual's environment.

Even though genetic makeup and environment play critical roles in shaping the person, Gottfredson (2002, 2005) maintained that the person is still able to influence or guide his or her own environment. In contrast to the established belief that choice is a process of selection, Gottfredson (1981, 1996, 2002) theorized that career choice and development could be viewed as a process of elimination by which a person actively eliminates occupational alternatives from consideration.

Social cognitive career theory. Social Cognitive Career Theory (SCCT) (Lent, 2005; Lent, Brown, & Hackett, 2002) is anchored in Bandura's self-efficacy theory (1977b, 1997), which suggested a relationship between people and the environment. SCCT offers three models of career development to explain (a) the development of academic and vocational interest, (b) how individuals make educational and career choices, and (c) educational and career performance and stability. The three models have different emphases centering on self-efficacy, outcome expectations, and personal goals. SCCT is consistent with early theory formulation by Bandura (1977a, 1977b) and others (Betz, Borgen, & Harmon, 1996; Hackett & Betz, 1981; Krumboltz, 1979).

Bandura's social learning theory. Research conducted by Albert Bandura in 1977 identified three major types of learning experiences: instrumental, associative, and vicarious. Instrumental learning experiences result from direct experience when an individual is positively reinforced or punished for some behavior and its associated cognitive skills. Associative learning experiences result from direct experience together with reinforcement when an individual associates some previously neutral event or stimulus with an emotionally laden stimulus. Vicarious learning experiences occur when individuals learn new behaviors and skills by observing the behaviors of others or by gaining new information and ideas through media such as books, films, and television.

Krumboltz's learning theory of career counseling. At the heart of Krumboltz's (1979) theory is Bandura's (1977b) Social Learning Theory (SLT). The original theory (Krumboltz, Mitchell, & Jones, 1976; Mitchell & Krumboltz, 1990), known as the Social Learning Theory of Career Decision Making (SLTCDM), developed into the Learning Theory of Careers Counseling (LTCC) (Mitchell & Krumboltz, 1996). The more recent version attempts to integrate practical ideas, research, and procedures to provide a theory that goes beyond an explanation of why people pursue various jobs.

> While the two theories were published at different times, they can be regarded as one theory with two parts. Part one (SLTCDM) explains the origins of career choice and part two (LTCC) explains what career counselors can do about many career related problems. (Mitchell & Krumboltz, 1996, p. 234)

Krumboltz has also worked on developing and integrating ideas about the role of chance (happenstance) in career decision making. However, in a study in 1979, Krumboltz focused strongly on how skills develop through learning experiences, such as course taking.

In summary, there are numerous career development theories and models. Career development theories help make sense of experiences. The five major career development theories discussed offer principles and concepts that have influenced career counseling, guidance, and research in the United States in the past few decades. The influence of abilities, achievement, and skills was emphasized in the decision making process that helped to determine one's choice of college major and future career aspirations.

Effect of high school course-taking on choice of college major. Though STEM encompasses all the sciences, technology, engineering, and mathematics, studies have found that students who take more mathematics and science courses in high school, compared to those students who do not, are more likely to graduate from college with a STEM major. In order to attempt to understand the effect of high school course taking on choice of major, a number of studies from differing viewpoints were reviewed.

A study conducted by Maple and Stage in 1991 concluded that selection of STEM majors by all students is declining. Maple and Stage (1991) also found the decline in science and mathematics major choice of particular concern. The model included subgroups in a longitudinal study of black, white, female, and male students. The study concluded that there were significant differences between the groups based on attitudes toward mathematics, math and science courses completed by the sophomore year in high school, and parental characteristics. These predictors of major choice (attitudes toward mathematics, math and science courses completed, and parental characteristics) indicated that there was a significant correlation between high school mathematics and science courses taken and the selection of a STEM major.

A study by Trusty in 2002 determined that United States students who completed a more rigorous high school academic program were more likely to graduate from college. For example, completing one high school mathematics course beyond the Algebra II level more than doubled the likelihood that college students would complete a bachelor's degree (Trusty, 2002). Trusty (2002) also found that the influence of rigorous high school course-taking on degree completion was consistently positive across socioeconomic status (SES) levels and across racial-ethnic groups.

Tyson et al. (2007), in a study of four-year universities in Florida, found that high school course-taking in science and mathematics created pathways toward future baccalaureate degree attainment in STEM. The study looked at underrepresented minorities in STEM and found that even though women completed high-level courses, overall, they did not complete the highest level science and mathematics courses. Even women who completed high-level science and mathematics courses were less likely than men to obtain STEM degrees. Tyson et al. (2007) also reported that Black and Hispanic students usually completed only lower level high school science and mathematics courses. However, the Black and Hispanic students who did take high-level science and mathematics courses were as likely as White students to pursue STEM degrees. The study concluded that gender disparities in STEM occurred because women were less likely to pursue STEM, but racial disparities occurred because fewer Black and Hispanic students were prepared for STEM in high school (Tyson et al., 2007).

Ebert (2011) concluded that students who take more math and science courses in high school increase their opportunity to enroll in STEM-related majors. The study by Ebert (2011) also found that some of the biggest gatekeepers to all majors, but especially math-related and engineering majors, were mathematics and science course taking and achievement. “Continued math and science course-taking in high school often leads students to entering a college major that uses those college preparation courses as prerequisites” (Ebert, 2011, p. 12).

LeBeau et al. (2012) conducted a study of students from 229 high schools to examine if a relationship existed between various student and high school characteristics and completion of a STEM major in college. The LeBeau et al. (2012) study found that several predictors were significant at the student level in determining a student's intent to major in STEM, including a student's ACT mathematics score, high school mathematics GPA, and gender. LeBeau et al. (2012) found that the high school mathematics curriculum completed by a student was unrelated to the student completing a STEM major in general or, more specifically, to completing an engineering or mathematics major. Second, there was a general finding that the completion of a STEM major was not dependent on particular high school characteristics, such as location or whether a school offered more than a single mathematics option to its students.

Wang (2013) conducted a study on the relationship between the high school curriculum (specifically math and science) that a student completes and his or her intent to pursue STEM upon entrance into postsecondary education. The study concluded that the intent to pursue STEM upon entrance into postsecondary education was significantly and positively influenced by 12^{th} grade math self-efficacy belief, exposure to math and science courses, and 12^{th} grade math achievement (Wang, 2013). Wang (2013) studied additional factors to determine intent to pursue a STEM major, including ethnic group, gender, 10^{th} grade math achievement and attitudes, and socioeconomic status. Wang (2013) found that "multiple group structural equation modeling analyses indicated heterogeneous effects of math achievement and exposure to math and science across racial groups, with their positive impact on STEM intent accruing most to White students and least to underrepresented minority students" (p. 1081). Results from the Wang (2013) study explained important racial differences in how pre-college learning and motivation exert an influence on students' intent to major in STEM.

The courses that students take during high school are expected to improve their skills and knowledge and to prepare them for their postsecondary careers. "Sadly, many K-12 students today have limited access to STEM classes or their limited experiences lead them to take only the minimum number of STEM classes. We seek to change that," stated former University of Idaho President Duane Nellis (2013) in his weekly *Friday Letter*. In 2005, the Idaho Legislature addressed the problem of fewer students taking science and math classes by increasing the graduation requirements from two required years of math and science to three years (Idaho State Department of Education, 2014). Dr. Mike Rush, executive director of the Idaho State Board of Education, stated:

> Right now, there are more questions than answers. The information on post-secondary school attendance is shining some light on higher education for Idahoans. Idaho hasn't had much data to help show how the investment taxpayers have made in colleges and getting kids ready for college is paying off. We haven't been able to say given this investment in higher education, how many students go to Idaho institutions? How many are transitioning to institutions out of state? (as quoted in Roberts, 2013, p. 1)

There has been a national trend toward more academically intensive course taking. Data from the National Center for Education Statistics (2012) indicated steady increases in numbers of credits for all college preparatory science and math courses taken in high school. In Idaho, stakeholders are anticipating the increase in academically intensive high school course taking to show increases in college science and math degrees awarded in the next decade.

Summary. The relationship between the high school curricula completed by a student and selection of major in college is not well understood, and available evidence of this relationship is mixed. This literature informs the purpose of the current study by offering a variety of definitions and theories associated with career choice and identifying a need for further research of factors that influence high school students who complete a rigorous high school academic program to choose or not choose STEM majors in college.

Science and Math Self-Efficacy

This section addresses science and math self-efficacy as a predictor of STEM pipeline entrance, performance, and perseverance.

Definition and determinants of self-efficacy. For this study, Rosenberg's Social Structural Biographical Approach is used to define self-concept, which is "the totality of the individual's thoughts and feelings with reference to oneself as an object" (Rosenberg, 1981, p. 595). Two well-known dimensions of self-concept are self-esteem ("feelings of self-acceptance, self-respect, and generally positive self-evaluation") (Rosenberg, Schooler, & Schoenbach, 1989, p. 1008) and self-efficacy ("belief in one's ability to master life's challenges and make things happen in accordance with one's plan") (Rosenberg & Kaplan, 1982, p. 4). Even though self-esteem and self-efficacy are related, they are not the same.

Self-efficacy, also called perceived ability, refers to the confidence people have in their abilities to successfully perform particular tasks (Bandura, 1997). Self-efficacy, as defined by Lent (2005), is "a dynamic set of beliefs that are linked to particular performance domains and activities" (p. 104). Self-efficacy can and does influence behavior and responses to barriers and difficulties. Self-efficacy beliefs are based largely on mastery experiences (performing tasks successfully), an individual's task specific experiences, and interpretation of those experiences (Bong & Skaalvik, 2003).

Many social cognitive theorists (Bandura, 1997; Schunk & Pajares, 2002; Zimmerman, 2000) have found that an individual's feelings of self-efficacy affect numerous aspects of behavior including activity choice, goal setting, effort, and persistence, in addition to learning and achievement. In fact, self-efficacy has been found to be a greater predictor of a learner's accomplishment than self-concept or self-esteem (Bong & Skaalvik, 2003).

Self-efficacy and academic achievement. Social Cognitive Career Theory (Lent, 2005; Lent, Brown, & Hackett, 2002) suggests that self-efficacy is shaped by four primary learning experiences: personal performance accomplishments, vicarious learning, social persuasion, and physiological and affective states. Lent (2005) suggested that of the four sources of learning experience in the Social Cognitive Career Theory, personal performance accomplishments have the most powerful influence on the status of self-efficacy.

Eccles, Wigfield, and Schiefele (1998) discovered that students with high math self-efficacy were more likely to enroll in mathematics courses than were students with low math self-efficacy in that area. Findings indicate that adolescents' career choices and occupational levels are tied to domains for which they have high self-efficacy, especially academic self-efficacy (Filer, 2009). On average, STEM self-efficacy is positively related to STEM task performance, meaning higher math or science self-efficacy is related to students' grades in math and science (Britner & Pajares, 2006).

> Students with low self-efficacy give up more easily in their academic pursuits than do students with high self-efficacy. A student's level of self-efficacy is influenced by past successes and failures, which can subsequently impact future successes or failures. (Witt-Rose, 2003, p. 2)

Self-efficacy and gender. Historically, women have been underrepresented in STEM fields. Similar to the dropout rates of underrepresented racial minority students in STEM disciplines, women drop out from STEM disciplines at higher rates than do men as they move from high school to college (National Research Council, 1991). Even today, this "leaky pipeline" has been somewhat puzzling because women enter college just as prepared as men in math and science (Griffith, 2010). On average, women more eagerly spend time studying than men do, a trait that should theoretically attract women to STEM fields, which generally assign more homework (Ahn, Arcidiacono, Hopson, & Thomas, 2014). The Ahn et al. (2014) research, while preliminary, suggests that women might value high grades more than men do and sort themselves into fields where grading curves are more lenient. It is not clear from the data why women might be more sensitive to grades than men are.

Offering some possible insight to the grade sensitivity issue, a report by the American Association of University Women (AAUW, 1991), *Shortchanging Girls, Shortchanging America*, revealed that girls' confidence in their academic abilities dropped radically from elementary to high school in the early 1990s. The decline is particularly significant in girls' and young women's belief in their math and science abilities. Although 81% of elementary school girls reported liking math, 31% of those same girls reported being good at math. By the time girls entered high school, 61% said they liked math, but only 15% believed they were good at math. Meanwhile, 84% of elementary boys reported liking math with 49% of the boys reporting that they were good at math. By high school, this percentage dropped to 72% of boys liking math and 25% believing they were good at math (AAUW, 1991). Figures 2 and 3 display adolescents' confidence in their ability declining as they grew older, according to the AAUW 1991 report. Although overwhelming numbers of adolescents "liked" math, significantly fewer believed they were "good at math." From elementary to high school, boys at every age were more confident in their math and science abilities than were girls. Boys and girls interpreted their grades and performance in STEM courses differently. For example, in a science class girls interpreted a "B" on an exam as a poor grade, indicating a lack of science ability, while boys receiving a "C" on the same exam viewed the grade as passing and, therefore, indicative of strong science ability. By high school, one in four boys thought he was good at math and science, but only one in seven girls believed that she was (AAUW, 1991).

Figure 2. Girls and Math: Liking Math vs. Confidence in Math Ability at the Elementary, Middle School, and High School Levels

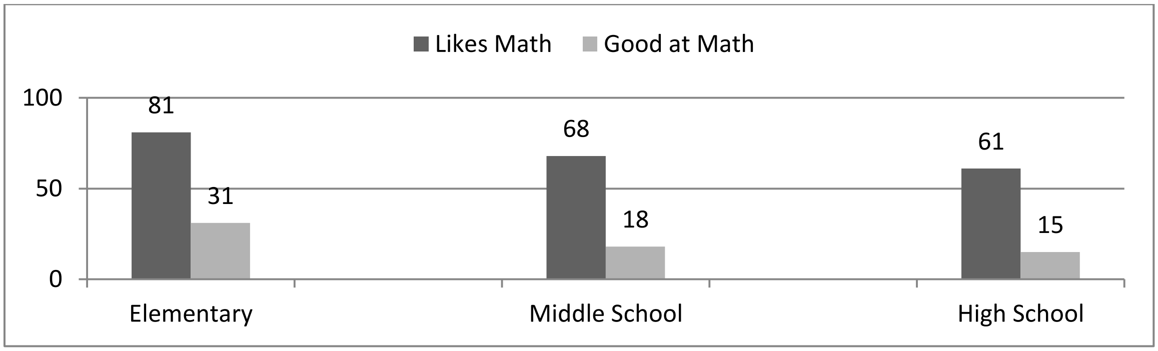


Figure2. From "Shortchanging Girls, Shortchanging America" (p. 11), by American Association of University Women (AAUW), 1991, Washington, DC: Author. Copyright 1994 by AAUW. Reprinted with permission.

Figure 3. Boys and Math: Liking Math vs. Confidence in Math Ability at the Elementary, Middle School, and High School Levels

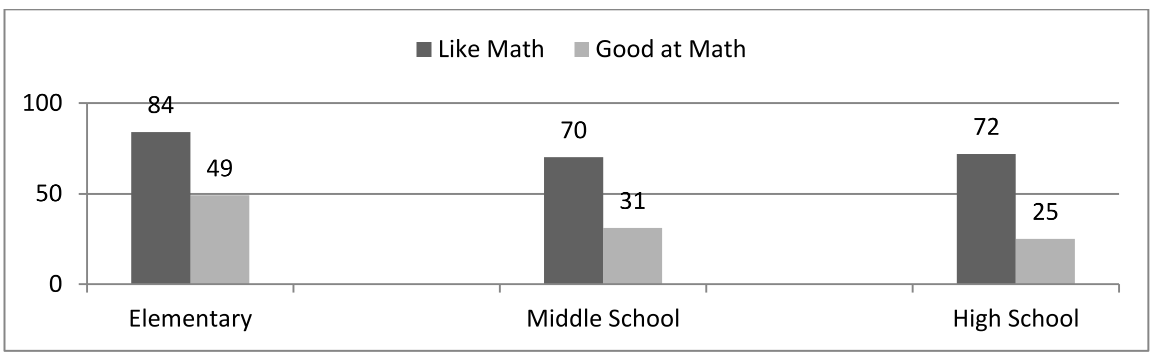


Figure2. From "Shortchanging Girls, Shortchanging America" (p. 11), by American Association of University Women (AAUW), 1991, Washington, DC: Author. Copyright 1994 by AAUW. Reprinted with permission.

Sadker & Sadker (1994) referred to gender differences in belief in math and science abilities as the "confidence gap." This gap is partly responsible for the shortage of women in science, technology, engineering, and mathematics classes and careers

(Eccles, 1994; Filer, 2009). Zeldin and Pajares (2000) found that “women aptly competent in mathematics often fail to pursue mathematics-related careers because they have low self-efficacy perceptions about their competence” (p. 218). Research also shows that young men and boys who receive high grades in STEM are generally self-congratulatory while young women and girls are generally modest (Schunk & Pajares, 2002).

A study to investigate women’s underrepresentation in STEM was conducted by the American Association of University Women and the National Science Foundation in 2010. This study drew on a large body of research, including “eight recent research findings that provide evidence that social and environmental factors contribute to the underrepresentation of women in science and engineering” (p. 14). Only 19% of first-year college women said that they intended to major in a STEM field compared to 35% of college men (Hill, Corbett, & St. Rose, 2010). By graduation from college, men outnumbered women in nearly every science and engineering field, and in some fields, such as physics, engineering, and computer science, the difference was dramatic with women earning only 20% of the bachelor’s degrees in these disciplines (Hill et al., 2010). Women’s representation among doctoral degree recipients in STEM fields has improved in the last 40 years. However, women are still underrepresented with only 34% of all doctorate degrees awarded in STEM being earned by women; most of those degrees were in biology. Among employees who hold doctorates, men represented a clear majority in all STEM fields. Figure 4 displays that men far outnumber women in the STEM field workforce.

Figure 4. Workers with Doctorates in the STEM Field Workforce, by Gender and Employment Status, 2008

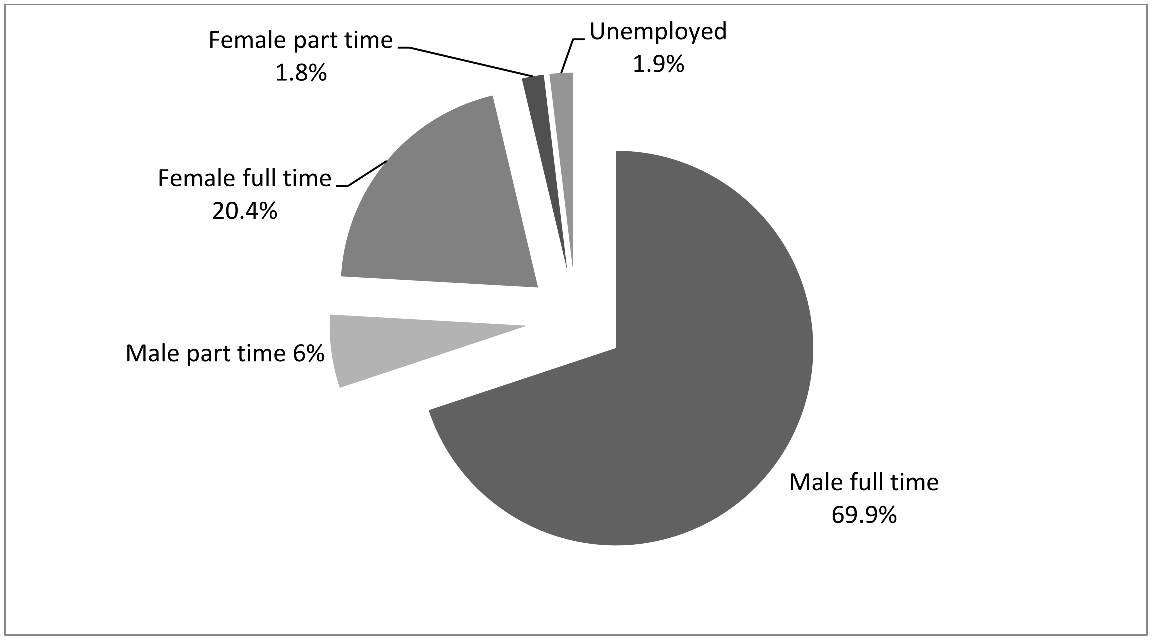


Figure 4. “Characteristics of Doctoral Scientists and Engineers in the Unites States,” 2008 (Detailed Statistical Tables) (NSF 13-302) National Science Foundation, Division of Science Resources Statistics, 2012, Arlington, VA: Author. Author’s analysis of Tables 1 and 4.

Over the past 60 years, there have been significant improvements in the college preparation of female students, and the college gender gap has changed dramatically. The ratio of male to female college graduates has not only decreased but reversed itself, and the majority of college graduates are now female (Niederle & Vesterlund, 2010). The gender gap in science and math has not changed. Despite the fact that the number of math and science courses taken by female high school students has increased, a gender difference “has been documented for a series of math tests including the AP calculus test, the mathematics SAT, and the quantitative portion of the Graduate Record Exam (GRE)” (Niederle & Vesterlund, 2010, p. 129). This gender difference in the fraction of males to females who score in the top five percent in mathematics has remained constant at two to one over the past 20 years according to the study conducted by Niederle and Vesterlund (2010).

The transition between high school and college is a critical period when many young women turn away from a STEM career path. Although women are the majority of college students, they are far less likely than their male peers to plan to major in a STEM field. Hill et al. (2010) concluded in their research that girls hold themselves to a higher standard than boys do in subjects like math and science, believing that they have to be exceptional to succeed. According to Hill et al. (2010), “cultural factors have been found to limit girls’ interest in mathematics and mathematically challenging careers” (p. 15). Women who do major in STEM fields in college tend to be well qualified (Hill et al., 2010). “Nevertheless, many of these academically capable women leave STEM majors early in their college careers” (p. 9).

Increasing STEM self-efficacy. Research has shown that interventions involving mastery experiences, such as performance accomplishment and vicarious learning, do increase STEM self-efficacy. The following studies suggest that the key to the effectiveness of these interventions is the addition of proximal goal setting and self-regulation.

An investigation by Luzzo, Hasper, Albert, Bibby, and Martinelli (1999) evaluated the effects of both performance accomplishment and vicarious learning experiences on math/science self-efficacy and career interests, goals (i.e., aspirations), and actions (i.e., choice of major and enrollment in courses) of career undecided college students. Undergraduates who possessed at least a moderate level of math ability and who self-reported at least a moderate level of career undecidedness were randomly assigned to 1 of 4 treatment conditions: performance accomplishment only, vicarious learning only, combined treatment (performance accomplishment and vicarious learning), or the control group.

The performance and vicarious learning study participants reported greater STEM self-efficacy compared to the control group immediately after the intervention. The post treatment self-efficacy rating for study participants in the combined treatment group was significantly higher than all other treatment groups. All study participants reported greater STEM self-efficacy four weeks after the intervention. The findings suggest that even minor, somewhat contrived interventions, can have significant impact on math/science self-efficacy (Luzzo et al., 1999).

Dunlap (2005) conducted research on Problem-Based Learning (PBL) as an apprenticeship for real-life problem solving, helping students acquire the knowledge and skills required in the workplace. Although the acquisition of knowledge and skills makes it possible for performance to occur, without self-efficacy the performance may not even be attempted. Dunlap (2005) examined how student self-efficacy, as it relates to software development professionals, changed while students were involved in a PBL environment. Thirty-one undergraduate university computer science students completed a 16-week capstone course in software engineering in which they were assigned a real-world problem and required to structure their problem resolution by setting proximal goals and creating action plans. At the end of the 16-week program, students reported significantly higher technology self-efficacy.

How prior performance influences the development of self-efficacy and how self-efficacy relates to subsequent performance are topics that are directing research efforts in self-efficacy. Research directed at closing the confidence gap and ultimately the gender gap in STEM has explored the effects of success in STEM performance and perceptions of STEM disciplines.

Current self-efficacy research in science and math. In a college study, science self-efficacy, mathematics self-efficacy, and self-efficacy for self-regulated learning were found to be distinct entities (Kennedy, 1996). In Kennedy's study, science self-efficacy did not significantly influence academic achievement. Kennedy theorized that achievement might be indirectly affected by a combination of self-efficacies for science, math, and self-regulated learning.

Since then, many studies have found a connection between self-efficacy and science achievement. In 1998, a study was conducted to determine if self-efficacy is a factor in determining nursing students' academic performance in bioscience and physical science courses (Andrew, 1998). Andrew (1998) developed and tested an instrument called "Self-Efficacy for Science" (SEFS). The SEFS was designed to predict academic performance in the science areas of a first-year undergraduate nursing course. A cohort of first-year students enrolled in an undergraduate nursing course responded to the SEFS. Andrew (1998) found that the self-efficacy of nursing students as indicated by performance on the SEFS was linked to the students' academic performance in science courses. Andrew (1998) concluded that by using the SEFS to assess a student's science self-efficacy, it may be possible to identify students who are likely to be academically unsuccessful and “develop educational strategies to assist them to improve their academic performance” (p. 601).

DeBacker and Nelson (2000) conducted a study to determine if the motivation to learn science and science self-efficacy are influenced by gender, the type of science class taken, and ability level of the student. The study was conducted at the high school level. The study revealed a number of differences between higher and lower achieving students and between students in biological versus physical science classes. They found that students in physical science courses who were considered higher achieving students had higher self-efficacy than did students in biological sciences who were considered lower achievers.

Some strategies for self-efficacy interventions are warranted. First, interventions to increase STEM self-efficacy should include a realistic assessment of aptitude. Self-efficacy should lead to the pursuit of difficult but attainable proximal goals. Moreover, self-efficacy interventions that overstate the student’s actual ability may encourage the student to adopt an unattainable goal. Second, to increase students’ performance and belief in their ability to perform a specific task, feedback must be accurate and focused on developing task-related knowledge and skills (AAUW, 2004). In addition, research by Weisgram and Bigler (2007) showed that a role model’s effect on young women’s STEM self- efficacy was greater when the role model addressed gender inequity in STEM fields.

Summary. The research on self-efficacy suggests that educators and research practitioners should pay as much attention to students’ self-efficacy—their perceptions of capability—as they do to students’ actual capability (Zeldin & Pajares, 2000). Because self-efficacy has been found to be significantly and positively related to science and math achievement, the importance of self-efficacy's influence on academic performance and perseverance in STEM fields cannot be understated. After all, ". . . efficacy beliefs partly shape the courses that lives take" (Bandura, 1997, p. 239).

Factors in Choice of College Major

Although some ancillary factors, such as earning potential and social status, have the potential to influence the choice of college major, this section reviews the theoretical factors that might influence a choice of major, including ability, interests and personality traits, influence of friends and family, career opportunities, and anticipated job satisfaction. A review of these studies is important in order to put this study into context.

The factors that shape motivational behaviors in STEM may be viewed from the contributing property of locus; that is, some factors are internal (i.e., ability, interests, self-efficacy, or personality traits), while other are external (i.e., academic experiences or influence of parents or role models). These factors interact with the individual's background in a powerful way to shape motivational behaviors.

Ability. In a study on scientific ability and creativity, Heller (2007) asked if exceptional ability is primarily achieved by cognitive problem-solving competence or by other factors, such as motivation. Heller (2007) concluded that "an excellent knowledge base is a necessary, but often not sufficient, condition for the development of expertise related to the creative solution of challenging complex problems" (p. 226).

In determining if ability is a factor in choice of college major, researchers have argued for the existence of specific innate abilities that are related to success in STEM fields (Heilbronner, 2011). Heilbronner (2011) conducted a study that investigated the reasons for talented men and women either remaining on, or leaving, the STEM pathway during the early stages of their lives. The study found that belief in one's own "ability to do well in STEM appeared to be a significant factor in determining whether individuals stayed in STEM" (Heilbronner, 2011, p. 896).

Gender differences. According to the Shriver Report (2009), women are half of all United States workers, and mothers are the primary breadwinners or co-breadwinners in nearly two-thirds of American families. This is a dramatic shift from just a generation ago, in 1967, when women made up only one-third of all workers (Shriver, 2009). But while women make up nearly half of the United States workforce, they make up only 26 percent of the science and engineering workforce (Halpern et al., 2007). In addition to the gender gap in the STEM workforce, a gender gap in academic achievement for men and women in STEM majors has been identified (Lubinski & Benbow, 2001). Zimbardo and Duncan (2012) reported:

> Girls outperform boys now at every level, from elementary school through graduate school. By eighth grade, for instance, only 20 percent of boys are proficient in writing and 24 percent proficient in reading. Young men's SAT scores, meanwhile, in 2011 were the worst they've been in 40 years. According to the National Center for Education Statistics (NCES), boys are 30 percent more likely than girls to drop out of both high school and college. . . it is predicted that women will earn 60 percent of bachelor's, 63 percent of master's and 54 percent of doctorate degrees by 2016. (p. 23)

Table 4

Percentage of Women among New Doctoral Recipients by Field: 2008-2009

Field of Study	Female Graduates
Social and behavioral sciences	60%
Public administration and services	61%
Physical and earth sciences	33%
Math and computer science	27%
Health Sciences	70%
Engineering	22%
Education	67%
Business	39%
Biological and agricultural sciences	51%
Arts and humanities	53%

Adapted from “Science and Engineering Doctorate Awards: 2007-2008,” by National Science Foundation, 2011. Copyright 2011 by National Science Foundation.

Table 5

Average Annual Change in Number of New Doctoral Degrees, by Gender: 1998-2009

Field of Study	Female	Male
Social and behavioral sciences	+3.2%	+0.5%
Public administration and services	+5.8%	+0.3%
Physical and earth sciences	+4.7%	+0.2%
Math and computer science	+7.0%	+4.3%
Health Sciences	+14.0%	+3.9%
Engineering	+6.0%	+3.3%
Education	+1.4%	+0.1%
Business	+1.9%	+0.3%
Biological and agricultural sciences	+7.7%	+1.2%
Arts and humanities	+1.4%	-0.2%

Adapted from “Science and Engineering Doctorate Awards: 2007-2008,” by National Science Foundation, 2011. Copyright 2011 by National Science Foundation.

In the past decade, as displayed in Tables 4 and 5, women earned more doctoral degrees in STEM than ever before (National Science Foundation, 2011). However, the actual picture in STEM education is more complicated than the previous statistics suggest. Although women did earn more doctoral degrees in some fields, such as biology, women are still underrepresented in other fields, such as engineering, math, astronomy, chemistry, earth and ocean sciences, physics, and computer science (National Science Foundation, 2011). Therefore, gender may influence choice of major (Halpern et al., 2007).

SAT/ACT scores. Since 1972, an early administration of the SAT has been widely used to identify intellectually talented seventh and eighth graders to enable their movement along paths leading to high achievement and success in adulthood (Colangelo, Assouline, & Gross, 2004). In a 30-year longitudinal study, researchers tracked the achievements of 286 male and 94 female talent search participants who, through early administration of the SAT, had been identified as talented in STEM fields (Lubinski, Benbow, Webb, & Bleske-Rechek, 2006). Utilizing surveys, researchers contacted participants to collect information on their creative, occupational, and life accomplishments. The group achieved exceptional success, as more than half had earned doctoral degrees (compared with 1% of the general population), and almost half had entered some type of STEM career. Lubinski et al. (2006) concluded that SAT scores, and particularly SAT-math scores, may characterize aptitude in STEM domains and identify students who were more likely to select a STEM college major.

Interests and personality traits. Bloom (1985) investigated the factors that may influence high-achieving individuals in a variety of fields to enter their chosen professions. Researchers interviewed prominent neurologists, along with their parents and instructors. Although many of the future neurologists did not know that they wanted to enter a specific field from a young age, most had been involved with science on a casual basis and knew that they were interested in science. Many enjoyed the experience of seeing what they could discover by setting up their own experiments and investigations (Sosniak, 1985).

Maple and Stage (1991) found that attitudes toward math predicted which students would major in a quantitative major within the first two years of college. Their study participants were 2,456 sophomore high school students in four subgroups (black females, black males, white females, and white males). Measures for seven variables were taken. The variables included separate measures of parents' education, internal locus of control, parent influence on student decision making, school influence on student decision making, standardized scores on five achievement tests, and attitudes toward mathematics. Significant findings that were common to the four subgroups were: the number of math and science courses completed through senior year; the number of science and math courses students planned to take as sophomores; test scores; and high school grades (Maple & Stage, 1991). Students in all subgroups of both high and above average ability received almost the same benefits from taking rigorous courses.

Researchers have investigated the role of student interest in STEM topics in the selection of STEM majors, observing that many talented students know early, sometimes as young children, that they want to enter a STEM career (Feist, 2006). Student interest or lack of interest may lead to students selecting more or fewer STEM courses. Tai, Liu, Maltese, and Fan (2006) investigated the influence of early career expectations on the final selection of careers. These researchers analyzed more than 3,300 students' responses to the National Educational Longitudinal Study. In this survey, eighth grade students were asked what they believed their careers would be when they reached the age of 30. Interestingly, when students expected to be working in a science career, they were

3.4 times more likely to earn a physical science and engineering baccalaureate degree than were those who did not expect a science-related career and 1.9 times more likely to earn a life science degree (Heilbronner, 2011).

Influence of parents or role models. Several studies have attempted to measure factors, including parents, which influence persistence in the STEM educational pipeline. While there is some debate among scholars as to the importance of various familial factors, all research seems to indicate that parents exert some kind of influence on their children's educational decisions.

In a study of practicing British scientists and engineers, Devine (1994) found that both men and women reported parental support and encouragement as influential factors in their choices of science over liberal arts studies. The subjects in the study did not report that parents pushed them towards specific careers. However, they did indicate that their parents had high educational expectations for them and supported their career decisions.

Farmer, Wardrop, and Rotella (1999) observed different results in a survey study performed in 1990. After surveying students who graduated in 1980, they found that parental influence did not contribute to students' decisions to pursue STEM studies. However, the authors hypothesized that this unexpected result occurred because the data were collected retrospectively and that the adults' recollections of experiences during their teens may not have been completely accurate.

In a study of parents, students, and college selection, Sztam (2003) found that parental influence played an important role in the college selection process for students. In this study, the parents clearly directed the college selection process by the constant advice they gave their children and by the financial limitations they communicated to them (Sztam, 2003).

Tenenbaum and Leaper (2003) examined parental beliefs about their children's science interest and ability. They found that parent designations of their children's science interest and ability (considered family science orientation) would predict the child's own science interest and self-efficacy. In a related study, Gilmartin, Li, and Aschbacher (2006) found that "family science orientation" was strongly related to interest in becoming a physical scientist and/or engineer (2006). A study by Gilmartin, Denson, Li, Bryant, and Aschbacher (2007) of the effect of gender ratios in high school science departments on students' science identities found a statistically significant effect of "Family Science Orientation."

Parents are essential for advising and motivating students to participate in activities and, more specifically, in science and mathematics courses, competitions, and events. Because of the developmental influences during high school for teens, they are influenced by both internal and external forces. Students are aware of and influenced academically by a home academic environment as well as a school academic environment (Ebert, 2011).

Career opportunities and anticipated job satisfaction. Undergraduate major is significantly correlated with job stability and job satisfaction (United States Department of Education, 2011). The impact of choice of major lasts far beyond student learning in college. The 2012 Freshman Survey published by the Cooperative Institutional Research Program, part of the Higher Education Research Institute at the University of California at Los Angeles, revealed heightened expectations that a college degree would provide economic security (Sander, 2013). As part of the survey, 88% of the freshman students surveyed at 283 four-year colleges and universities said the ability to get a better job was a very important reason to go to college. This is a 22% increase over the results of the freshman survey in 1976 (Sander, 2013).

Recent data from the National Science Foundation (2012) reported that 66% of science and engineering graduates are not employed in a STEM field. STEM attrition continues 10 years into the workforce, as 46% of workers with a bachelor's degree in STEM leave the field (Carnevale et al., 2011).

Summary. The research indicates that majoring in a STEM field in college is the result of an assortment of students' academic achievements and abilities, interests and attitudes, and family characteristics, as well as anticipated job satisfaction and career opportunities. Thus far, the literature has recognized that self-efficacy is a key factor in an individual's college major selection along with personal attributes such as gender, ability, and parental influence. Practically speaking, one thing is as sure today as it was 24 years ago: "Math/Science major choice is of concern in light of the occupational demands created by advancing technology" (Maple & Stage, 1991, p. 37).

Literature Summary

This chapter examined literature related to the history and trends nationally and statewide in regard to STEM enrollment in higher education, high school preparation and its impact on college major selection, science and math self-efficacy, and college major choice factors. Multiple studies have been conducted to try to ascertain what factors influence undergraduates in their selection of field of concentration. The current study is needed to help clarify and reveal the relationship between high school course taking, self-efficacy, and STEM major selection. The next chapter describes the methodology and procedures of the study designed to determine the factors that influence students who complete a rigorous high school academic program to choose, or not choose, STEM majors in college.

CHAPTER III

Methodology

The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho, who complete a rigorous high school academic program, to choose or not choose STEM majors in college. This study was conducted using a quantitative methods approach. The analyses in this quantitative study used data derived from the survey instrument. Additional data were obtained from open-ended questions included in the survey. Together the quantitative data and the comments from the open-ended questions provided insights to the choice of a college major. Differences based on various student demographics were explored, as well as graduates' perceptions of their self-efficacy in math and science, self-reported decision factors, and capstone course completion. The study focused on high school graduates of 2010, 2011, and 2012 from three public high schools in a school district in southern Idaho.

The following research questions guided this study:

1. What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?
2. What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?
3. What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

The following methodology discusses the participants, instrumentation, procedures, and data analysis.

Participants

This study was conducted using high school level data because empirical evidence supports the importance of high school math and science course enrollments in students' choices of math and science college majors (Farmer et al., 1999). Participants in this study were high school graduates of 2010, 2011, and 2012 from three public high schools in a school district in southern Idaho. According to the data provided by the school district, 553 graduates met the researcher's criteria to serve as the sample participants in this study. The numbers of honors graduates selected for this study were similar from year to year (172 graduates in 2010, 186 graduates in 2011, and 195 graduates in 2012), and the numbers of total graduates from each of the three public high schools studied were approximately the same.

Students from these three years graduated from high school having to complete only four credits of science and math in order to meet Idaho State Board of Education requirements. Completion of capstone math and science credits by these graduates in these areas was by choice; they were not required for graduation. Graduates since 2012 have been required to complete six credits of math and science for high school graduation, increasing the likelihood of capstone course completion. The sample participants were selected on the basis of their academic success in high school. Current research suggests that several high school factors are correlated with student success in college. Measures of academic performance across high schools, including mean mathematics and verbal SAT scores, have a statistically significant association with a higher college enrollment rate (Fogg & Harrington, 2010; Johnson, 2011).

Therefore, the following factors were used to select the sample participants in this study: (a) designation as an academic honors student and (b) completion of one or more capstone course(s) in math or science. Academic honors students were individuals who attained a 3.6 or higher grade point average in high school and had completed at least two credits of Advanced Placement (AP) or honors coursework before high school graduation (Pocatello/Chubbuck School District, 2012).

A capstone course was defined as an advanced course coming at the end of a sequence of courses with the specific objective of integrating a body of relatively fragmented knowledge into a unified whole (Durel, 1993). For this study, capstone courses in math were delimited to trigonometry, honors trigonometry, honors college algebra, college algebra, AP calculus, honors calculus, calculus, and AP statistics. Capstone courses in science were delimited to AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, honors physics, and anatomy and physiology. The science and math courses identified for this study were selected and termed "capstone" because all of the courses were the highest science or math courses available in the school district and were offered at all three public high schools.

These criteria were chosen because it was assumed that students who met both criteria were more likely to pursue post-secondary education and, therefore, choose a college major (Fogg & Harrington, 2010). The sample participants in this study were verified as meeting the selection criteria by the high school counselors and registrars at the three high schools.

Instrumentation

Quantitative data were collected with a survey instrument. Since no existing instrument exactly fit the scope of this study, a survey instrument was adapted from the "Assessing Women and Men in Engineering Pre-College Recruiting Survey" (AWE, 2010), a national survey developed by Pennsylvania State University and University of Missouri and sponsored by the National Science Foundation (National Science Board, 2012). The questions in the survey from the Assessing Women and Men in Engineering (AWE) instrument refer to engineering alone. Therefore, questions were modified and additional questions included to collect information vital to this study. The Assessing Women and Men in Engineering *STEM Assessment Tools* (2013), found on the Project website, states that anyone may "adapt AWE surveys to fit your activity and add sets of questions as appropriate. All AWE surveys are tested and validated" (para. 37). Since the Assessing Women and Men in Engineering Project allowed free use of the survey instruments, no permission to use and adapt the survey was required.

The instrument for this study included demographic items, questions related to science and math self-efficacy, and five open-ended questions. Three of the open-ended questions asked the survey participant about his/her college major, and the other two questions asked the participant to include comments about STEM major choice and any additional thoughts he or she may have on college major choice. The twelve self-efficacy questions had response options on a Likert scale: 0-strongly disagree, 1-disagree, 2-slightly disagree, 3-neither disagree nor agree, 4-slightly agree, 5- agree, 6-strongly agree, 7- don't know. The survey instrument was synthesized into 25 questions to increase the likelihood of responses because, according to Patten (2001), shorter surveys increase response rate. A copy of the survey instrument can be found in Appendix A. Copies of the letter that was included in the survey and informed consent information are in Appendix B.

Procedures

Permission to conduct this study was obtained from the Human Subjects Committee at Idaho State University. Following Human Subjects Committee approval, the researcher requested the student directory data information from the school district. Permission was sought from the school district for release of directory data, including parental addresses and phone numbers for the potential study participants. Potential study participants were high school graduates and were chronologically and legally adults. In accordance with school district policies and Family Educational Rights and Privacy Act (FERPA, 1974) regulations, all identified potential study participants were verified as meeting selection criteria by high school counselors and registrars at the three high schools.

Due to the fact that some of the study participant contact information from the school district directory was not accurate or was not available, family members and/or friends were contacted. If a recent graduate indicated that he or she had not attended college, the responses were not included in the study. Because the study survey was sent out using SurveyMonkey©, email addresses were necessary to contact study participants. The researcher located email addresses for the study participants from class reunion lists, friends, family members, and several universities that provide email addresses in their online student directories.

While the directory data were being assembled, the researcher pilot tested the survey instrument for clarity. Survey items 1-12, derived from the "Assessing Women and Men in Engineering" Survey (AWE, 2010), were previously tested for validity and reliability and were tested and validated on both males and females. The Association of Women in Engineering (AWE) Project was founded in 2001, supported by a National Science Foundation (NSF) Research on Gender in Engineering and Science (GSE) grant. The AWE Project brought together eight institutions (University of Missouri, Penn State University, The University of Texas at Austin, University of Louisville, University of Arizona, Rensselaer Polytechnic Institute, Georgia Institute of Technology, and Virginia Tech) to develop and field test AWE surveys and instruments. However, since the AWE survey was altered for this study, additional validity and reliability tests were conducted.

Reliability of the survey instrument was tested using Cronbach's alpha procedure (Worthen, White, Fan, & Sudweeks, 1999). Cronbach's alpha is a measure of the internal consistency of the scores obtained from a single administration of a single test. Cronbach's alpha can be used with all types of test items (Cronbach, 1951). Alpha levels above .70 are considered adequate (Furr & Bacharach, 2008). To assess the reliability of the survey instrument, Cronbach's alpha procedure was calculated for STEM self-efficacy with subscales in career success expectations, math and science self-efficacy, and math and science outcome expectations.

The questions added to the survey were validated for content by five professors with expertise in survey design and validation and piloted via SurveyMonkey© by 20 cadets at the United States Military Academy, West Point, New York. West Point cadets have academic backgrounds consistent with participants in this study. In addition, since the researcher had two sons who were cadets at the United States Military Academy the use of cadets for the pilot test was convenient for the researcher. The respondents to the pilot test indicated that the survey was clear, the questions were easily understood, and there was no need for modifications to the survey instrument.

The survey was sent to the email addresses of the study participants via SurveyMonkey©. The survey instrument included a letter of introduction with survey instructions and the informed consent information. Participants were informed that completion of the online survey served to imply informed consent. Surveys were initially emailed on a Wednesday to improve the response rate (Shinn, Baker, & Briers, 2007). The survey was available over a three-week period. Emails were sent to non-respondents after one week and the day before the survey closed to remind participants to complete the survey.

After the surveys were received, the data were entered into the Statistical Package for the Social Sciences (SPSS) version 22 for statistical analysis. Data will be stored for seven years in hard copy in a file at the researcher's residence and electronically on a personal computer to which only the researcher will have access.

To ensure confidentiality, no personally identifying data were collected as part of the study except directory data. At the conclusion of the study, all directory information was destroyed, and the survey data and results have been presented only in aggregate form.

Data Analysis

This was a quantitative study using a survey instrument to examine the factors that influence students who complete a rigorous high school academic program to choose or not choose STEM majors in college. SPSS version 22 was used to perform statistical analyses, including Cronbach's alpha, descriptive statistics, and inferential statistics, including chi-square analyses and binary logistic regression.

Research Questions 1, 2, and 3 employed SPSS for data analysis. Research Question 3 also focused on data gathered from the open-ended questions in the survey instrument. The data in response to Research Questions 1, 2, and 3 were reported using graphs, charts, and tables.

The research questions and quantitative data derived from the survey responses were examined as follows:

Research Question 1. What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?

Descriptive statistics, including frequencies and corresponding percentages and measures of central tendency (means, standard deviations, and ranges), were used to analyze this question. Data were also analyzed with chi-square. Analyses were conducted of demographic variables (sex, ethnicity, parental educational levels, and parental income) in relation to STEM college major selection. Because this study sought to explore which variables contribute to the selection of a college STEM major, bivariate comparisons were conducted to determine if any of the independent variables contributed significantly to the selection or rejection of a college STEM major.

Research Question 2. What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?

College STEM major choice was analyzed in relation to each of the 12 questions related to science and math self-efficacy. This question was analyzed using descriptive statistics, chi-square, and binary logistic regression.

Chi-square was used to determine if the choice of a STEM major in college is dependent on science and math self-efficacy. Chi-square was the appropriate test of statistical significance in this case (Gall, Gall, & Borg, 2003). Additionally, logistic regression was used to determine if a dichotomous outcome of whether a participant selected a STEM major could be predicted. Logistic regression provides a sound way to analyze data when describing and testing hypotheses about relationships between a dichotomous dependent variable and one or more independent variables (Peng, Lee, & Ingersoll, 2002).

Research Question 3. What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

Self-reported decision factors influencing the selection of a college major were explored. Additionally, the responses to Survey Question 18 (*"Which of the following science or math course(s) did you take in high school?"*) were examined to determine if capstone course completion influenced choice of a college STEM major. Responses to Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*), Survey Question 21 (*"Did you change your major?"*), and Survey Question 23 (*"What is your college major now? Or if you have graduated,* *what was your college major?"*) were analyzed to determine whether a change of college major affected selection of a college STEM major or non-STEM major.

The survey instrument provided an opportunity for respondents to identify why they chose their college major. If they did not choose a STEM major, the participants were given the opportunity to explain why they did not. This question was analyzed using basic descriptive statistics, chi-square, and binary logistic regression analyses.

The answers to the open-ended questions were sorted manually by the researcher. Each response was reviewed, and a comprehensive list of potential themes was developed by the researcher. The analyses of the comments from the open-ended questions yielded four broad themes: (1) lack of interest, (2) difficulty, (3) aversion, and (4) lack of time.

Summary

This chapter described and explained the participants, instrumentation, procedures, and analysis of the proposed study. The methodology described in this chapter addressed the research questions and provided results reported in Chapter IV.

CHAPTER IV

Results

The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho, who complete a rigorous high school academic program, to choose or not choose STEM majors in college. The study was guided by the following research questions:

1. What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?
2. What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?
3. What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

There are few studies focused specifically on analyzing multiple factors that can contribute to a student's choice of a college STEM major. No one study has attempted to analyze multiple factors and draw conclusions that may be useful in encouraging students to enter and stay in the STEM pipeline. This study was designed to address this gap in empirical knowledge. This study has incorporated many of the most common factors of STEM college major choice into one study and has attempted to add to the knowledge base in an original and interesting way that may be replicated with larger samples.

This study was conducted using a quantitative methods approach. The analyses in this quantitative study used data derived from the survey instrument. Additional data were obtained from open-ended questions included in the survey. Together the quantitative data and the comments from the open-ended questions provide insights into the choice of college major. This chapter presents the findings from the analysis of the survey data. This chapter first reports respondent demographics and the survey items that measure the STEM self-efficacy portion of the survey. Then the findings from the quantitative data are reported relative to the research questions. The last part of the chapter focuses specifically on the data derived from the comments and is organized thematically.

Pilot Test

A pilot test of the survey instrument was conducted via SurveyMonkey© with 20 cadets at the United States Military Academy in West Point, New York, as subjects. The pilot test had a 100% response rate. The respondents to the pilot test indicated that the survey was clear, the questions were easily understood, and there was no need for modifications to the survey instrument.

Survey Distribution and Response Rate

Participants in this study were high school graduates from three public high schools in a school district in southern Idaho in 2010, 2011, and 2012. According to the data provided by the school district, 553 graduates met the researcher's criteria to serve as participants in this study (academic honors students). Tables 6 and 7 display numbers of male and female academic honors students compared to the general male and female senior (grade 12) populations for 2010 – 2012. Table 8 displays the total number of academic honors students compared to the general senior (grade 12) population. Totals within all three tables are in bold type to assist with ease of reading.

Table 6

Study Sample Characteristics: Male Academic Honors Students Compared to Senior Male (Grade 12) Population for 2010, 2011, and 2012

Year	School	Academic Honors Students	Total School Senior Male Population	Academic Honors Students as % of Total Senior Male Population
	A	27	143	18.9
2010	B	32	157	20.4
	C	20	116	17.2
	Totals:	**79**	**416**	**19.0**
	A	20	101	19.8
2011	B	33	162	20.4
	C	18	112	16.1
	Totals:	**71**	**375**	**18.9**
	A	34	143	23.8
2012	B	30	143	21.0
	C	23	157	14.7
	Totals:	**87**	**443**	**19.6**

Table 7

Study Sample Characteristics: Female Academic Honors Students Compared to Senior Female (Grade 12) Population for 2010, 2011, and 2012

Year	School	Academic Honors Students	Total School Senior Female Population	Academic Honors Students as % of Total Senior Female Population
	A	32	104	30.8
2010	B	36	127	28.4
	C	25	123	20.3
	Totals:	**93**	**354**	**26.3**
	A	31	132	23.5
2011	B	56	157	35.7
	C	28	125	22.4
	Totals:	**115**	**414**	**27.8**
	A	38	126	30.2
2012	B	39	110	35.5
	C	31	141	22.0
	Totals:	**108**	**377**	**28.7**

Table 8

Study Sample Characteristics: Total Academic Honors Students Compared to Senior (Grade 12) Population for 2010, 2011, and 2012

Year	School	Total Academic Honors Students	Total Senior Population	Academic Honors Students as % of Total Senior Population
	A	59	247	23.9
2010	B	68	284	23.9
	C	45	239	18.8
	Totals:	**172**	**770**	**22.3**
	A	51	233	21.9
2011	B	89	319	27.9
	C	46	237	19.4
	Totals:	**186**	**789**	**23.6**
	A	72	269	26.8
2012	B	69	253	27.3
	C	54	298	18.1
	Totals:	**195**	**820**	**23.8**

The numbers of academic honors graduates were similar from year to year (172 graduates in 2010, 186 graduates in 2011, and 195 graduates in 2012), and the numbers of graduates from each of the three public high schools were approximately the same for the three years. The number of male academic honors students averaged 19.2% of the male population; the number of female academic honors students averaged 27.6% of the female population. The total number of academic honors graduates selected for the study averaged 23.2% of all graduates from the study schools.

Each of the high school graduates eligible to take part in this study was asked via email to participate and received a link to the electronic survey. (See survey in Appendix A.) Respondents gave their informed consent by responding to the online survey. (See informed consent in Appendix B.) Of the 553 surveys emailed, 34 emails bounced back as undeliverable, six individuals opted to not participate by requesting to be removed from the survey participant list, and 352 individuals did not respond.

Eighty-one surveys were returned to the researcher after the first emailing. An email reminder was sent out one week later to non-respondents, resulting in the return of 33 additional surveys. A final email reminder was sent out two weeks after the initial survey email, and an additional 47 survey responses were received.

A total of 161 high school graduates responded to the survey for a response rate of 31.4%. Of the 161 responses, 156 were complete, yielding a completion rate of 96.9% and an overall return rate of 30.4%. The five returned surveys that were excluded from the study had only one or two questions answered by the respondents and were deemed unusable by the researcher.

Reliability

The study survey was derived from the "Assessing Women and Men in Engineering" Survey (Assessing Women and Men in Engineering (AWE), 2010). The survey was previously tested for validity and reliability by the authors and was also tested and validated on males and females. Since the AWE survey was slightly altered by deletion of some of the original survey questions, additional reliability tests were conducted using Cronbach's alpha procedure. Cronbach's alpha is a measure of the internal consistency of items in a scale. Alpha levels above .70 are considered acceptable levels of internal consistency (Furr & Bacarach, 2008).

The survey questions were divided into three thematic scales (career success expectations, math and science self-efficacy, and math and science outcome expectations) regarding student perceptions about STEM self-efficacy. Table 9 displays the results of the Cronbach's alpha procedure for the three self-efficacy thematic scales and the individual questionnaire items within each scale.

Table 9

Internal Reliability of Self-Efficacy Scales and Score Ranges, Means, and Standard Deviations for Individual Questionnaire Items Within the Scales (n = 156)

Question Number	Question	α	Score Ranges	*M*	*SD*
Career Success Expectations		**.84**			
Q5	A degree in a **science** discipline will allow me to get a job and use my talents and creativity.		0-6	4.2	1.6
Q11	A degree in a **math** discipline will allow me to get a job and use my talents and creativity.		0-6	4.1	1.5
Math and Science Self-Efficacy		**.82**			
Q2	I can complete the **science** requirements for most college majors.		1-6	5.0	1.1
Q3	I think I will succeed (earn an A or B) in my **science** courses.		1-6	5.2	1.1
Q8	I can complete the **math** requirements for most college majors.		1-6	5.0	1.2
Q9	I think I will succeed (earn an A or B) in my **math** courses.		1-6	5.0	1.3
Math and Science Outcome Expectations		**.84**			
Q1	Taking **science** courses will help me to keep my career options open.		0-6	4.7	1.5
Q4	Doing well at **science** will enhance my career/job opportunities.		0-6	4.7	1.6
Q6	Doing well in **science** will increase my sense of self-worth.		0-6	4.1	1.7
Q7	Taking **math** courses will help me to keep my career options open.		0-6	4.9	1.2
Q10	Doing well at **math** will enhance my career/job opportunities.		0-6	4.9	1.1
Q12	Doing well in **math** will increase my sense of self-worth.		0-6	4.0	1.7

As displayed in Table 9, the Cronbach's alpha coefficient for the career success expectations scale was α = .84. Cronbach's alpha coefficient for the math and science self-efficacy scale was α = .82. Cronbach's alpha coefficient for the math and science outcome expectations scale was α = .84. Cronbach's alpha coefficient for each of the measures of STEM self-efficacy was strong, ranging from .82 to .84. The Cronbach's alpha coefficients for all three scales were above .70, indicating acceptable reliability for internal consistency for the survey.

Research Question 1: What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?

The selected demographic variables were sex, race/ethnicity, father's highest education level attained, mother's highest education level attained, and parents' total income. Demographic information will be reported first, followed by findings about the relationship between selected demographics of recent high school graduates and choice of a college STEM major.

The survey responses yielded nominal, ordinal, and ratio data and were analyzed using basic descriptive statistics and chi-square. A chi-square test was used to determine if a relationship existed between the choice of college major (STEM or non-STEM) and selected demographics. The chi-square test is appropriate for data that are categorical or that may be in ranked category form (Gall et al., 2003).

Respondent Demographics

Table 10 displays respondent demographics in terms of sex, race/ethnicity, father's highest education level attained, mother's highest education level attained, and parents' total income for the 156 respondents who completed the survey. The highest frequency for each demographic variable is indicated in bold type.

Table 10

Demographic Variables (n = 156)

Variable	Respondent Demographics	*n*	%
Sex	Male	41	26.3
	Female	**115**	**73.7**
Race/Ethnicity	**Caucasian/White American**	**147**	**94.2**
	Non-Caucasian/American	9	5.8
Father's Education Level	Not a high school graduate	0	0.0
	High school graduate or equivalent	15	9.6
	Some college, no degree	33	21.2
	Post-secondary certificate or license	6	3.9
	Associate degree	8	5.1
	Bachelor's degree	**42**	**26.9**
	Master's degree	31	19.9
	Professional or doctorate degree	20	12.8
	I Don't Know	1	0.6
Mother's Education Level	Not a high school graduate	0	0.0
	High school graduate or equivalent	20	12.8
	Some college, no degree	31	19.9
	Post-secondary certificate or license	4	2.6
	Associate degree	20	12.8
	Bachelor's degree	**54**	**34.6**
	Master's degree	17	10.9
	Professional or doctorate degree	9	5.8
	I Don't Know	1	0.6
Parents' Total Income	Less than $10,000	4	2.6
	$10,000 to $24,999	3	1.9
	$25,000 to $39,999	5	3.2
	$40,000 to $ 59,999	29	18.6
	$60,000 to $79,999	21	13.5
	$80,000 to $99,999	18	11.5
	$100,000 or more	**49**	**31.4**
	I Don't Know	27	17.3

Sex. As shown in Table 10, 73.7% (*n* = 115) of the respondents were female, and 26.3% (*n* = 41) were male. Because all of the respondents were high school graduates from the 2010, 2011, and 2012 graduating years, all respondents were in the 18-24 age range. These results indicated that most of the respondents were female between 18 and 24 years of age (i.e., traditional college-age students).

Ethnicity. For the statistical analyses, ethnicity was recoded to Caucasian/White American and non-Caucasian/American because of the low representation of minorities. As shown in Table 10, 94.2% (*n* = 147) of the respondents identified themselves as Caucasian/White American, and 5.8% (*n* = 9) identified themselves as non-Caucasian/American.

Father's education level. As shown in Table 10, 26.9% (*n* = 42) of the respondents indicated that the highest education level attained by their fathers was a bachelor's degree. Nearly 33% (*n* = 51) of the respondents indicated that their fathers had attained a master's degree or higher. The fathers of all respondents had obtained at least a high school diploma or the equivalent.

Mother's education level. As shown in Table 10, 34.6% (*n* = 54) of the respondents indicated that the highest education level attained by their mothers was a bachelor's degree. Slightly over 16% (*n* = 26) of the respondents indicated that their mothers had attained a master's degree or higher. The mothers of all respondents had obtained at least a high school diploma or the equivalent.

Parents' total income. As shown in Table 10, 56.4% (*n* = 88) of respondents reported that their parents' total income was $60,000 or higher, although 17.3% (*n* = 27) of the respondents reported that they did not know their parents' total income.

Demographics and Enrollment in College STEM Majors

Tables 11 through 15 display the number of respondents who selected or did not select a college STEM major according to demographic variables. The number of respondents in these comparisons varies from the total number of study respondents because some respondents did not indicate a choice of a STEM or non-STEM major in their survey responses. Totals within Tables 13, 14, and 15 are in bold type to assist with ease of reading.

Table 11

Sex of Respondent and Enrollment in a College STEM Major (n = 134)

	STEM		Non-STEM		
Sex	*n*	%	*n*	%	χ^2 = .095, *p* = .76
Male	14	38.9	22	61.1	
Female	41	41.8	57	58.2	

Sex. Only 134 of the 156 respondents who reported their sex also identified their choice of a STEM or non-STEM major. As shown in Table 11, 41.8% (*n* = 41) of female respondents indicated that they were enrolled in college STEM majors, and 58.2% (*n* = 57) of female respondents indicated that they were not enrolled in college STEM majors. For males, 38.9% (*n* = 14) of respondents indicated that they were enrolled in college STEM majors, and 61.1% (*n* = 22) of respondents indicated that they were not enrolled in college STEM majors. The sex of the respondent made no significant difference on choosing a college STEM major, χ^2 (1, *n* = 134) = .095, *p* = .76. The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A *p* value of .76 means that there was a 76% probability that any deviation from the expected number of respondents who chose a STEM major or non-STEM major was due to chance alone.

Sex of the study respondents was not a determining factor in choice of a STEM major in college.

Table 12

Ethnicity and Enrollment in a College STEM Major (n = 134)

	STEM		Non-STEM		
Ethnicity	*n*	%	*n*	%	$\chi^2 = 2.62$, $p = .11$
Caucasian/White American	49	39.2	76	60.8	
Non-Caucasian/American	6	66.7	3	33.3	

Ethnicity. Only 134 of the 156 respondents who reported their ethnicity also identified their choice of a STEM or non-STEM major. As shown in Table 12, 39.2% ($n = 49$) of Caucasian/White American respondents indicated that they were enrolled in college STEM majors, and 60.8% ($n = 76$) of Caucasian/White American respondents indicated that they were not enrolled in college STEM majors. For Non-Caucasian/Americans, 66.7% ($n = 6$) of respondents indicated that they were enrolled in college STEM majors, and 33.3% ($n = 3$) of respondents indicated that they were not enrolled in college STEM majors. The ethnicity of the respondent made no significant difference on choosing a college STEM major, χ^2 (1, $n = 134$) = 2.62, $p = .11$. This result was perhaps due to the small number of non-Caucasian/American respondents. The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A *p* value of .11 means that there was an 11% probability that any deviation from the expected number of respondents who chose a college STEM major or non-STEM major was due to chance alone. Ethnicity of the study respondents was not a determining factor in choice of a STEM major in college.

Table 13

Father's Education Level and Enrollment in a College STEM Major (n = 133)

Father's Education Level	STEM *n*	STEM %	Non-STEM *n*	Non-STEM %	$\chi^2 = 7.64$, $p = .27$ Row Totals	Row %
High School	8	6.0	3	2.3	11	8.3
Some College	11	8.3	20	15.0	31	23.3
Certificate	3	2.3	3	2.3	6	4.6
Associate Degree	4	3.0	4	3.0	8	6.0
Bachelor's Degree	15	11.3	20	15.0	35	26.3
Master's Degree	7	5.3	19	14.3	26	19.6
Professional or Doctorate Degree	7	5.3	9	6.8	16	12.1
Totals:	**55**	**41.5**	**78**	**58.7**		

Note. Percentages have been rounded and may not equal 100%.

Father's education level. Only 133 of the 156 respondents who reported their father's education level also identified their choice of a STEM or non-STEM major. As shown in Table 13, 41.5% (*n* = 55) of respondents indicated that they were enrolled in college STEM majors, and 58.7% (*n* = 78) of respondents indicated that they were not enrolled in college STEM majors. Of the respondents who chose a college STEM major, the most frequent education levels reported for fathers were bachelor's degree (11.3%, *n* = 15) and some college (8.3%, *n* =11). Of the respondents who chose a non-STEM college major, the most frequent education levels reported for fathers were bachelor's degree (15%, *n* = 20) and some college (15%, *n* = 20). Father's educational level made no significant difference on choosing a college STEM major, χ^2 (6, *n* = 133) = 7.64, *p* = .27). The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A *p* value of .27 means that there was a 27% probability that any deviation from the expected number of respondents who chose a STEM major or non-STEM major was due to chance alone. The education level of the fathers of the respondents was not a determining factor in choosing a STEM major in college.

Table 14

Mother's Education Level and Enrollment in a College STEM Major (n = 133)

Mother's Education Level	STEM *n*	STEM %	Non-STEM *n*	Non-STEM %	$\chi^2 = 3.06$, $p = .80$ Row Totals	Row %
High School	7	5.3	9	6.8	16	12.1
Some College	11	8.3	18	13.5	29	21.8
Certificate	3	2.3	1	.8	4	3.1
Associate Degree	8	6.0	11	8.3	19	14.3
Bachelor's Degree	19	14.3	25	18.8	44	33.1
Master's Degree	4	3.0	10	7.5	14	10.5
Professional or Doctorate Degree	3	2.3	4	3.0	7	5.3
Totals:	**55**	**41.5**	**78**	**58.7**		

Note. Percentages have been rounded and may not equal 100%.

Mother's education level. Only 133 of the 156 respondents who reported their mother's education level also identified their choice of a college STEM or non-STEM major. As shown in Table 14, 41.5% ($n = 55$) of respondents indicated that they were enrolled in college STEM majors, and 58.7% ($n = 78$) of respondents indicated that they were not enrolled in college STEM majors. Of the respondents who chose a college STEM major, the most frequent education levels reported for mothers were bachelor's degree (14.3%, $n = 19$) and some college (8.3%, $n = 11$). Of the respondents who chose a non-STEM college major, the most frequent education levels reported for mothers were bachelor's degree (18.8%, $n = 25$) and some college (13.5%, $n = 18$). Mother's education level made no significant difference on choosing a college STEM major, χ^2 (6, $n = 133$) = 3.06, $p = .80$). The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A p value of .80 means that there was an 80% probability that any deviation from the expected number of respondents who chose a college STEM major or non-STEM major was due to chance alone. The education level of the mothers of the respondents was not a determining factor in choosing a STEM major in college.

Table 15

Parents' Total Income and Enrollment in a College STEM Major (n = 111)

Parents' Total Income	STEM *n*	STEM %	Non-STEM *n*	Non-STEM %	$\chi^2 = 4.50$, $p = .61$
Less than $10,000	2	1.8	1	0.9	
$10,000 to $24,999	0	0.0	2	1.8	
$25,000 to $39,999	2	1.8	1	0.9	
$40,000 to $59,999	11	9.9	15	13.5	
$60,000 to $79,999	6	5.4	13	11.7	
$80,000 to $99,999	9	8.1	9	8.1	
$100,000 or more	19	17.1	21	18.9	
Totals:	**49**	**44.1**	**62**	**55.8**	

Note. Percentages have been rounded and may not equal 100%.

Parents' total income. Only 111 of the 156 respondents who reported their parents' total income also identified their choice of a STEM or non-STEM major. As shown in Table 15, 44.1% (*n* = 49) of respondents indicated that they were enrolled in a college STEM major, and 55.8% (*n* = 62) of respondents indicated that they were not enrolled in a college STEM major. Of the respondents who chose a college STEM major, the most frequent levels of parents' total income reported were $100, 000 or more (17.1%, *n* = 19) and $40,000 to $59,999 (9.9%, *n* =11). Of respondents who chose a non-STEM college major, the most frequent levels of parents' total income reported were $100, 000 or more (18.9%, *n* = 21) and $40,000 to $59,999 (13.5%, *n* = 15). Parents' total income made no significant difference on choosing a college STEM major, χ^2 (6, *n* = 111) = 4.50, $p = .61$. The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A *p* value of .61 means that there was a 61%

probability that any deviation from the expected number of respondents who selected a college STEM major or non-STEM major was due to chance alone. The parents' total income level as reported by the respondents was not a determining factor in choosing a STEM major in college.

Summary

The relationship between selected demographics (sex, race/ethnicity, father's highest educational level attained, mother's highest educational level attained, and parents' total income) and respondents' choice of a college STEM major was studied through use of chi-square analyses. No statistically significant relationship was found between any selected demographic variable and respondents' choice of a college STEM major.

Research Question 2: What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?

Basic descriptive statistics, chi-square, and binary logistic regression were used to respond to this question. Self-efficacy information will be reported first, followed by the findings about the relationship between self-efficacy and factors that influenced the choice of a college STEM major.

Descriptive statistics for the responses to the 12 questions evaluating STEM self-efficacy are displayed on Tables 16 and 17. For each item, respondents replied to a prompt and rated their level of agreement with the item on an 8-point Likert scale ranging from 0 (*strongly disagree*) to 6 (*strongly agree*) with 7 indicating *don't know*.

STEM Self-Efficacy

Table 16 displays respondents' ratings of their STEM self-efficacy according to their responses to the survey questions. The items in Table 16 are ranked from highest to lowest based on the total percentage of respondents who indicated "*agree*" or "*strongly agree"* on the question.

Table 16

STEM Self-Efficacy. (Ranked from Highest to Lowest Based on Total Percentage of Respondents Who Indicated "Agree" or "Strongly Agree")(n = 131*)*

	Don't Know	Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree
Q3: I think I will succeed (earn an A or B) in my **science** courses.								
	0.8%	0.0%	1.7%	3.4%	3.4%	9.2%	33.6%	47.9%
Q9: I think I will succeed (earn an A or B) in my **math** courses.								
	0.9%	0.0%	3.5%	7.8%	0.9%	6.9%	34.5%	45.7%
Q8: I can complete the **math** requirements for most college majors.								
	0.0%	0.0%	1.7%	5.2%	5.2%	8.7%	35.7%	43.5%
Q2: I can complete the **science** requirements for most college majors.								
	0.0%	0.0%	2.5%	2.5%	2.5%	14.3%	39.5%	38.7%
Q7: Taking **math** courses will help me to keep my career options open.								
	0.0%	0.9%	0.0%	7.8%	4.3%	12.9%	40.5%	33.6%
Q10: Doing well at **math** will enhance my career/job opportunities.								
	0.0%	0.9%	0.0%	5.3%	3.5%	16.8%	41.6%	31.9%
Q4: Doing well at **science** will enhance my career/job opportunities.								
	0.9%	1.7%	1.7%	10.3%	8.6%	8.6%	27.6%	40.5%
Q1: Taking **science** courses will help me to keep my career options open.								
	0.0%	2.5%	3.4%	5.0%	5.0%	17.7%	28.6%	37.8%
Q5: A degree in a **science** discipline will allow me to get a job and use my talents and creativity.								
	0.9%	.9%	7.6%	8.5%	13.6%	16.1%	27.1%	25.4%
Q6: Doing well in **science** will increase my sense of self-worth.								
	0.9%	1.7%	10.3%	4.3%	20.5%	14.5%	21.4%	26.5%
Q11: A degree in a **math** discipline will allow me to get a job and use my talents and creativity.								
	0.9%	2.6%	1.7%	13.0%	13.0%	20.9%	29.6%	18.3%
Q12: Doing well in **math** will increase my sense of self-worth.								
	0.9%	1.7%	9.6%	7.0%	20.0%	13.9%	27.0%	20.0%

The respondents agreed or strongly agreed most often with Survey Questions 3, 9 and 8. Table 16 indicates that 81.5% of respondents agreed or strongly agreed with Survey Question 3 (*"I think I will succeed (earn an A or B) in my* ***science*** *courses*"), 80.2% of respondents agreed or strongly agreed with Survey Question 9 (*"I think I will succeed (earn an A or B) in my* ***math*** *courses"*), and 79.2% of respondents agreed or strongly agreed with Survey Question 8 (*"I can complete the* ***math*** *requirements for most college majors"*). The respondents agreed or strongly agreed least often with Survey Questions 6, 11, and 12. Table 16 indicates that 47.9% of respondents agreed or strongly agreed with Survey Question 6 (*"Doing well in* ***science*** *will increase my sense of self-worth"*), 47.9% of respondents agreed or strongly agreed with Survey Question 11 (*"A degree in a* ***math*** *discipline will allow me to get a job and use my talents and creativity"*), and 47% of respondents agreed or strongly agreed with Survey Question 12 (*"Doing well in* ***math*** *will increase my sense of self-worth"*).

Table 17 displays respondents' ratings of their STEM self-efficacy through the sample size, mean scores, standard deviation, and skewness statistics for each survey question. The survey questions are listed from highest mean score to lowest mean score. The higher the mean score, the greater the agreement with that item.

Table 17

STEM Self-Efficacy Survey Questions. (Ranked from Highest to Lowest Mean Score)

Question Number	Question	*n*	*M*	*SD*	Skew	Standard Error of Skew
Q3	I think I will succeed (earn an A or B) in my **science** courses.	156	6.2	1.1	0.45	0.19
Q8	I can complete the **math** requirements for most college majors.	156	6.0	1.2	0.05	0.19
Q9	I think I will succeed (earn an A or B) in my **math** courses.	156	6.0	1.3	0.05	0.19
Q2	I can complete the **science** requirements for most college majors.	156	6.0	1.1	0.03	0.19
Q10	Doing well at **math** will enhance my career/job opportunities.	156	5.9	1.1	-0.29	0.19
Q7	Taking **math** courses will help me to keep my career options open.	156	5.9	1.2	-0.34	0.19
Q1	Taking **science** courses will help me to keep my career options open.	156	5.7	1.5	-0.62	0.19
Q4	Doing well at **science** will enhance my career/job opportunities.	156	5.7	1.6	-0.63	0.19
Q5	A degree in a **science** discipline will allow me to get a job and use my talents and creativity.	156	5.2	1.6	-1.43	0.19
Q11	A degree in a **math** discipline will allow me to get a job and use my talents and creativity.	156	5.1	1.5	0.28	0.19
Q6	Doing well in **science** will increase my sense of self-worth.	156	5.1	1.7	0.14	0.19
Q12	Doing well in **math** will increase my sense of self-worth.	156	5.0	1.7	-0.04	0.19

The highest mean scores were for Survey Questions 3, 8, 9, and 2. Table 17 indicates that the highest mean scores were 6.2 for Survey Question 3 (*"I think I will* *succeed (earn an A or B) in my **science** courses*"), 6.0 for Survey Question 8 (*"I can complete the **math** requirements for most college majors*"), 6.0 for Survey Question 9 (*"I think I will succeed (earn an A or B) in my **math** courses*"), and 6.0 for Survey Question 2 (*"I can complete the **science** requirements for most college majors*").

The lowest mean scores were for Survey Questions 11, 6, and 12. Table 17 indicates that the lowest mean scores were 5.1 for Survey Question 11 (*"A degree in a **math** discipline will allow me to get a job and use my talents and creativity*"), 5.1 for Survey Question 6 (*"Doing well in **science** will increase my sense of self-worth*"), and 5.0 for Survey Question 12 (*"Doing well in **math** will increase my sense of self-worth*").

Overall, respondents reported means ≥ 5.0 ("Agree"), indicating high levels of STEM self-efficacy. Mean scores for STEM self-efficacy ranged from 5.0 to 6.2. The standard deviations indicate that the individual responses ranged from 1.1 to 1.7 points away from the mean. The distributions of the scores for the self-efficacy data were asymmetric or skewed. Six of the variables were negatively skewed (skewness -0.04 to -1.43), which means that the majority of respondents indicated high ratings on these items while a few respondents indicated low ratings. Negative skewness occurred because the mean and the median were both less than the mode. The means were lowered by the few respondents who indicated low ratings because the mean is sensitive to skew. Even though several of the variables were negatively skewed, skewness was within the +/- 0.5 range, making all but Survey Questions 1, 4, and 5 approximately symmetric. Survey Question 1, (*"Taking **science** courses will help me to keep my career options open"*) (skewness = -0.62), Survey Question 4, (*"Doing well at **science** will enhance my career/job opportunities"*) (skewness = -0.63), and Survey Question 5, (*"A degree in a*

science *discipline will allow me to get a job and use my talents and creativity"*) (skewness = -1.43) were negatively skewed and outside the +/- 0.5 range.

Self-Efficacy as a predictor of college STEM major. Logistic regression is the most appropriate statistical model to use to analyze self-efficacy as a predictor of STEM college major choice. Logistic regression provides a sound way to analyze data when describing and testing hypotheses about relationships between a dichotomous dependent variable and one or more independent variables (Peng et al., 2002). All logistic regression tests used in this study met the assumptions of logistic regression as outlined by Tabachnick and Fidell (2007, p. 441). The significance level for all statistical tests was set at $p < .05$. Additional chi-square analyses were conducted to determine whether a relationship existed between STEM self-efficacy and the likelihood of choosing a college STEM major.

Two binary logistic regression analyses were conducted to determine if any of the self-efficacy measures in math and/or science significantly predicted the selection of a college STEM major. The 12 self-efficacy questions were blocked in groups of six and measured against the dummy coded (0 = *not STEM major*, 1 = *STEM major*) outcome variables retrieved from the respondent answers to Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*). Block 1 analyzed science self-efficacy responses while Block 2 analyzed math self-efficacy responses. Analyses were conducted in two separate blocks to avoid exceeding the recommended ratio of predictor variables to the number of cases.

Table 18 displays the scores, degrees of freedom, and significance for each of the self-efficacy questions (Survey Questions 1-12). The survey questions were blocked in groups of six. Block 1 included Survey Questions 1-6, and Block 2 included Survey Questions 7-12. The statistically significant survey questions are in bold type to assist with ease of reading.

Table 18

Self-Efficacy Survey Questions 1-12 (Blocked in Groups of Six) as Predictors of College STEM Major

Variable	Score	*df*	*p*	
Block 1				$\chi^2 = 19.68$, $p = .00$
Q1	.03	1	.86	
Q2	2.27	1	.13	
Q3	2.25	1	.13	
Q4	**14.96**	**1**	**.00**	
Q5	.63	1	.43	
Q6	.00	1	.95	
Block 2				$\chi^2 = 26.22$, $p = .00$
Q7	.46	1	.50	
Q8	.11	1	.74	
Q9	**12.25**	**1**	**.00**	
Q10	**5.37**	**1**	**.02**	
Q11	.10	1	.76	
Q12	.02	1	.89	

Of the 156 surveys, only 131 were included in the analyses due to 25 respondents not having reported the necessary data. The forward Wald binary logistic regression for the first block of six self-efficacy questions (Q1 to Q6) yielded a statistically significant prediction model for choosing a college STEM major, -2 Log Likelihood = 157.87, χ^2 (1, n = 131) = 19.68, p = .00. Even though as a Block, Survey Questions 1-6 were statistically significant, Survey Question 4 (*"Doing well at* ***science*** *will enhance my career/job opportunities*") was the only self-efficacy question in Block 1 that was statistically significant (p = .00).

The forward Wald binary logistic regression for the second block of six self-efficacy questions (Q7 to Q12) yielded a statistically significant prediction model for choosing a college STEM major , -2 Log Likelihood = 151.32, χ^2 (1, *n* = 131) = 26.22, *p* = .00. Even though as a Block, Survey Questions 7-12 were statistically significant, Survey Question 9 (*"I think I will succeed (earn an A or B) in my* ***math*** *courses"*) and Survey Question 10 (*"Doing well at* ***math*** *will enhance my career/job opportunities"*) were the only self-efficacy questions in Block 2 that were statistically significant.

Table 19 displays the binary logistic regression coefficients, the Wald tests, and odds ratios for the statistically significant predictors (Survey Questions 4, 9, and 10) from the two analyses shown in Table 18.

Table 19

Self-Efficacy Survey Questions 4, 9, and 10 as Predictors of College STEM Major

Variables	*B*	SE-*B*	Wald	*df*	Sig.	Exp (*B*)	R^2
Block 1							.19
Q4	.60	.16	14.96	1	.00	1.8	
Block 2							.24
Q9	.85	.24	12.25	1	.00	2.3	
Q10	.48	.21	5.37	1	.02	1.6	

As shown in Table 19, Survey Question 4 (*"Doing well at* ***science*** *will enhance my career/job opportunities*"), Survey Question 9 (*"I think I will succeed (earn an A or B) in my* ***math*** *courses"*) and Survey Question 10 (*"Doing well at* ***math*** *will enhance my career/job opportunities"*) showed a statistically significant relationship between self-efficacy and the selection of a college STEM major ($p < .05$).

Survey Question 4 (*"Doing well at **<u>science</u>** will enhance my career/job opportunities*") was statistically significant. As shown in Table 19, respondents who indicated high self-efficacy in Survey Question 4 were 1.8 times more likely to major in a STEM field than those respondents who did not show high self-efficacy in this survey question. The Nagelkerke pseudo R^2 = .19, indicated the model accounted for 19% of the total variance. As shown in Table 20, the model was able to predict who would or would not choose a STEM major with a 69.5% accuracy rate.

Survey Question 9 (*"I think I will succeed (earn an A or B) in my **<u>math</u>** courses"*) was statistically significant. As shown in Table 19, respondents who indicated high self-efficacy in Survey Question 9 were 2.3 times more likely to major in a STEM field than those respondents who did not show high self-efficacy in this survey question, when controlling for responses to Survey Question 10. The Nagelkerke pseudo R^2 = .24, indicated the model accounted for 24% of the total variance. As shown in Table 20, the model was able to predict who would or would not choose a STEM major with a 68.7% accuracy rate.

Survey Question 10 (*"Doing well at **<u>math</u>** will enhance my career/job opportunities"*) was statistically significant. As shown in Table 19, respondents who indicated high self-efficacy in Survey Question 10 were 1.6 times more likely to major in a STEM field than those respondents who did not show high self-efficacy in this survey question, when controlling for responses to Survey Question 9. The Nagelkerke pseudo R^2 = .24, indicated the model accounted for 24% of the total variance. As shown in Table 20, the model was able to predict who would or would not choose a STEM major with a 70.2% accuracy rate.

Table 20 displays the percentages of cases (0 = *not STEM major*, 1= *STEM major*) that can be predicted by the model for the statistically significant predictors (Survey Questions 4, 9, and 10). Average predictive percentages are in bold type for ease of reading.

Table 20

Accuracy Percentages for Predicting Selection of a College STEM Major (Survey Questions 4, 9, and 10)

Observed Variables		Predicted: College Major Non-STEM	Predicted: College Major STEM	Predicted: Percentage
Block 1				
Q4	Non-STEM	57	20	74.0
	STEM	20	34	63.0
	Average Percentage			**69.5**
Block 2				
Q9	Non-STEM	54	23	70.1
	STEM	18	36	66.7
	Average Percentage			**68.7**
Q10	Non-STEM	61	16	79.2
	STEM	23	31	57.4
	Average Percentage			**70.2**

As shown in Table 20, Survey Question 4 in Block 1 was able to predict who would or would not choose a college STEM major with a 69.5% accuracy rate. Table 20 indicates that Survey Question 9 in Block 2 was able to predict who would or would not choose a college STEM major with a 68.7% accuracy rate, and Survey Question 10 in Block 2 was able to predict who would or would not choose a college STEM major with a 70.2% accuracy rate.

Self-reported factors influencing selection of college major. Self-reported factors influencing the selection of a college major were explored in terms of parental advice, SAT/ACT scores, capstone course(s) completion, advanced placement course(s), job shadow experience(s), peer (friend) recommendation, employment while in high school, school counselor advice, and personal experience (i.e., science fair, etc.). Table 21 displays the frequency distribution of major factors reported by respondents as influencing their selection of a college major. The survey allowed respondents to select all factors that influenced their selection of a college major.

Table 21

Self-Reported Factors Influencing Selection of College Major (n = 156)

Factors Influencing Selection of College Major	*n*	%
Personal Experience (i.e., science fair, etc.)	115	73.7%
Peer (Friend) Recommendation	82	52.6%
Parental Advice	56	35.9%
Advanced Placement Course(s)	56	35.9%
Job Shadow Experience	23	14.7%
SAT/ACT Score	20	12.8%
Employment in High School	15	9.6%
School Counselor Advice	13	8.3%
Capstone Course(s)	7	4.5%

As shown in Table 21, having a Personal Experience (73.7%, n = 115) was the most common factor indicated by respondents as having influenced selection of a college major, followed by Peer (Friend) Recommendation (52.6%, n = 82), Parental Advice (35.9%, n = 56), and Advanced Placement Course(s) (35.9%, n = 56). The least common factors indicated by respondents as having influenced selection of a college major were Employment in High School (9.6%, n = 15), School Counselor Advice (8.3%, n = 13), and Capstone Course(s) (4.5%, n = 7). Respondents collectively reported 387 factors as influencing their selection of their college major, averaging 2.5 decision factors per respondent.

Tables 22, 23, and 24 display the chi-square analyses of the statistically significant self-efficacy survey questions (Survey Questions 4, 9, and 10) from Table 19 and the individual decision factors that influenced choice of a college STEM major.

Table 22

*Self-Efficacy Survey Question 4 ("Doing well at **science** will enhance my career/job opportunities") and Factors that Influenced Choice of College Major (n = 155)*

Decision Factors	χ^2	*p*	*V*
Parental Advice	3.61	.73	.15
SAT/ACT Score	3.16	.79	.14
Capstone Course(s)	2.42	.88	.13
Advanced Placement (AP) Course(s)	9.15	.17	.24
Job Shadow During High School	3.36	.76	.15
Peer (Friend) Recommendation	7.15	.31	.22
Employment During High School	4.10	.66	.16
School Counselor Advice	3.05	.80	.14
Personal Experience	4.39	.63	.17

Table 23

*Self-Efficacy Survey Question 9 ("I think I will succeed (earn an A or B) in my **math** courses") and Factors that Influenced Choice of College Major (n = 155)*

Decision Factors	χ^2	*p*	*V*
Parental Advice	3.55	.62	.15
SAT/ACT Score	3.90	.56	.16
Capstone Course(s)	4.71	.45	.17
Advanced Placement (AP) Course(s)	2.95	.71	.14
Job Shadow During High School	1.48	.92	.10
Peer (Friend) Recommendation	2.77	.74	.13
Employment During High School	3.62	.61	.15
School Counselor Advice	5.96	.31	.20
Personal Experience	6.26	.28	.20

Table 24

*Self-Efficacy Survey Question 10 ("Doing well at **math** will enhance my career/job opportunities") and Factors that Influenced Choice of College Major (n = 155)*

Decision Factors	χ^2	*p*	*V*
Parental Advice	5.30	.38	.18
SAT/ACT Score	3.02	.70	.14
Capstone Course(s)	4.45	.49	.17
Advanced Placement (AP) Course(s)	2.75	.74	.13
Job Shadow During High School	4.68	.46	.17
Peer (Friend) Recommendation	16.10	.01	.32
Employment During High School	2.92	.71	.14
School Counselor Advice	2.86	.72	.14
Personal Experience	4.34	.50	.17

Of the 156 surveys, only 155 were included in the analyses reported in Tables 22, 23, and 24 due to one respondent not having reported the necessary data to be included. A chi-square analysis was run to explore whether the statistically significant self-efficacy survey questions (Survey Questions 4, 9, and 10) and factors that influenced choice of a college major could be used to predict the likelihood of selecting a STEM college major. The comparison between factors that influenced choice of a college major and self-efficacy Survey Questions 4, 9, and 10 indicated the relationships were not statistically significant (adjusted $\alpha = .05/9 = .005$, $p < .005$).

Summary

Binary logistic regression analyses were conducted to determine if any of the self-efficacy measures in math and/or science significantly predicted the outcome of the selection of a college STEM major. Self-efficacy Survey Questions 4, 9, and 10 were found to be statistically significant for predicting college STEM major choice. There was no statistical relationship found between self-efficacy and factors that influenced choice of a college major as reported by respondents.

Research Question 3: What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

Self-reported decision factors influencing the selection of a college major were explored in terms of parental advice, SAT/ACT scores, capstone course(s) completion, advanced placement course(s), job shadow experience(s), peer (friend) recommendation, employment while in high school, school counselor advice, and personal experience (i.e., science fair, etc.). Additionally, the responses to Survey Question 18 (*"Which of the following science or math course(s) did you take in high school?"*) were examined to determine if an influence was evident between capstone course completion and choice of a college STEM major. The science and math capstone courses included in the analyses were calculus, honors calculus, AP calculus, college algebra, honors college algebra, AP statistics, trigonometry, honors trigonometry, anatomy and physiology, AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, and honors physics.

College Major Decision Factors as an Influence on College STEM Major Choice

Results from Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*) and Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*) were compared to the college major decision factors. The frequency distribution of major decision factors reported by respondents as influencing their selection of a college major were displayed previously. (See Table 21.)

Analyses were performed to determine if respondents' answers to Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*) were different from their answers to Survey Question 23 (*"What is *your college major now? Or, if you have graduated, what was your college major?"*) The purpose of these analyses was to determine not only if a respondent's major had changed but also to determine if a change of major was into or out of a STEM college major.

The responses to factors that influenced choice of a college major in Survey Question 20 (*"Which of the following factors contributed to your decision to select the major identified in **question 19 above**?"*) were measured against the dummy coded (0 = *not STEM major*, 1 = *STEM major*) outcome variables retrieved from the respondent answers to Survey Questions 19 and 23, and binary logistic regression analyses were performed. Table 25 presents the frequency with which Survey Questions 19 and 23 identified a STEM or non-STEM major when compared to factors that influenced choice of a college major from Survey Question 20. STEM majors are in bold type for ease of reading.

Table 25

Self-Reported College Major Decision Factors and Choice of a College STEM Major

	College Major (Entering) (Q19) *n* = 134				College Major (Now) (Q23) *n* = 128			
Decision Factors (Q20)	**STEM**		Non-STEM		**STEM**		Non-STEM	
	n	**%**	*n*	%	***n***	**%**	*n*	%
Parental Advice	**45**	**33.6**	89	66.4	**44**	**34.4**	84	65.6
SAT/ACT Score	**15**	**11.2**	119	88.8	**14**	**10.9**	114	89.1
Capstone Course(s)	**6**	**4.5**	128	95.5	**6**	**4.7**	122	95.3
AP Course(s)	**38**	**28.4**	96	71.6	**37**	**28.9**	91	71.1
Job Shadow	**20**	**14.9**	114	85.1	**18**	**14.1**	110	85.9
Peer Recommendation	**34**	**25.4**	100	74.6	**33**	**25.8**	95	74.2
Employment	**11**	**8.2**	123	91.8	**11**	**8.6**	117	91.4
School Counselor Advice	**10**	**7.5**	124	92.5	**9**	**7.0**	119	93.0
Personal Experience	**82**	**61.2**	52	38.8	**80**	**62.5**	48	37.5

Note. The survey allowed respondents to select all factors that contributed to college major decision.

A large number of respondents in STEM majors identified Personal Experience (entering = 61.2%; now = 62.5%) as the decision factor that influenced their choice of a college STEM major, followed by Parental Advice (entering = 33.6%; now = 34.4%) and AP (advanced placement) Courses (entering = 28.4%; now = 28.9%). Capstone Course(s) (entering = 4.5; now = 4.7%) was the decision factor selected by the fewest number of respondents as influencing selection of a college STEM major.

The decision factors that respondents in non-STEM majors identified most frequently as influencing their choice of non-STEM college majors were Capstone Course(s) (entering = 95.5; now = 95.3%), Advice of the School Counselor (entering = 92.5%; now = 93.0%), and Employment while in High School (entering = 91.8%; now = 91.4). Personal Experience (entering = 38.8%; now = 37.5%) was the decision factor selected by the fewest number of respondents as influencing selection of a non-STEM college major.

Table 26 displays the binary logistic regression coefficients, the Wald tests, and the odds ratios for each predictor in Survey Question 20 (*"Which of the following factors contributed to your decision to select the major identified in **question 19 above**?"*) compared with Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*).

Table 26

Survey Question 19 and Predictors of College STEM Major Choice (n = 134)

Decision Factors	*B*	SE-*B*	Wald	*df*	Sig.	Exp (*B*)	R^2
							.14
Parental Advice	-.29	.42	.49	1	.486	.75	
SAT/ACT Score	.22	.62	.13	1	.719	1.25	
Capstone Course(s)	1.53	1.01	2.29	1	.131	4.61	
AP Course(s)	1.08	.43	6.37	1	.012	2.94	
Job Shadow	.16	.54	.09	1	.768	1.17	
Peer Recommendation	.03	.45	.00	1	.955	1.03	
Employment	.57	.68	.72	1	.397	1.77	
School Counselor Advice	-.74	.81	.84	1	.360	.48	
Personal Experience	.48	.41	1.34	1	.247	1.61	

The binary logistic regression analyses yielded no statistically significant relationship between responses to Survey Question 19 and factors that influenced choice of a college major , -2 Log Likelihood = 167.21, χ^2 (9, n = 134) = 14.23, $p < .011$ (adjusted α = .10/9 = .011). The Nagelkerke pseudo R^2 = .14 indicated that the nine college major choice variables together accounted for 14% of the total variance in college major selection (STEM vs. non-STEM).

Table 27 displays the binary logistic regression coefficients, the Wald tests, and the odds ratios for each predictor in Survey Question 20 (*"Which of the following factors contributed to your decision to select the major identified in* ***question 19 above****?"*) compared with Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*).

Table 27

Survey Question 23 and Predictors of College STEM Major Choice (n = 128)

Variables	*B*	SE-*B*	Wald	*df*	Sig.	Exp (*B*)	R^2
							.11
Parental Advice	-.21	.45	.22	1	.64	1.23	
SAT/ACT Score	-.24	.68	.12	1	.73	.79	
Capstone Course(s)	1.22	1.00	1.49	1	.22	3.40	
¤ AP Course(s)	.68	.44	2.42	1	.12	1.97	
Job Shadow	.07	.56	.01	1	.91	1.07	
Peer Recommendation	-.27	.48	.31	1	.58	.77	
Employment	.89	.70	1.64	1	.20	2.44	
School Counselor Advice	-1.90	1.17	2.64	1	.10	.15	
Personal Experience	-.12	.42	.08	1	.77	.89	

None of the predictors in Survey Question 20 were statistically significant for selecting a STEM major, $p < .011$ (adjusted $\alpha = .10/9 = .011$). The binary logistic regression analyses yielded no statistically significant relationship between responses to Survey Question 23 and factors that influenced choice of a college major, -2 Log Likelihood = 157.89, χ^2 (9, n = 128) = 10.42, $p < .011$ (adjusted $\alpha = .10/9 = .011$). The Nagelkerke pseudo $R^2 = .11$ indicated the model accounted for 11% of the total variance in college major selection (STEM vs. non-STEM).

Capstone Courses as an Influence on College STEM Major Choice

For this study, rigorous academic records or coursework was defined as the completing of dual-credit, advanced placement, or honors coursework while enrolled in high school (Medhanie & Vanden Berk, 2013). Respondents were asked to report which capstone course(s) they took during high school. As defined for this study, a capstone course is an advanced course coming at the end of a sequence of courses with the specific objective of integrating a body of relatively fragmented knowledge into a unified whole (Durel, 1993). For the purpose of this study, capstone courses in math were delimited to calculus, honors calculus, AP calculus, college algebra, honors college algebra, AP statistics, trigonometry, and honors trigonometry. Capstone courses in science were delimited to anatomy and physiology, AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, and honors physics. Logistic regression analyses were performed to assess whether or not capstone course completion in math and science while in high school significantly predicted the frequency of selecting a STEM major in college.

Capstone course completion. Table 28 displays the frequency distribution of math and/or science capstone course completion reported by the survey respondents. The survey allowed respondents to select all the capstone science and math courses that were taken while in high school.

Table 28

Self-Reported Capstone Course Completion (n = 156)

Capstone Science and/or Math Courses Taken in High School	*n*	%
Honors Trigonometry	90	57.7%
Honors Chemistry	85	54.5%
Anatomy & Physiology	82	52.6%
AP Calculus	64	41.0%
AP Biology	58	37.2%
Trigonometry	51	32.7%
Honors Calculus	50	32.1%
College Algebra	50	32.1%
Honors College Algebra	50	32.1%
Honors Physics	42	26.9%
Calculus	32	20.5%
AP Statistics	31	19.9%
AP Chemistry	28	18.0%
AP Physics	23	14.7%
College Chemistry	16	10.3%

As shown in Table 28, more than 50% of the respondents surveyed took honors trigonometry (57.7%, n = 90), honors chemistry (54.5%, n = 85), and anatomy and physiology (52.6%, n = 82). Less than 20% of the respondents took AP statistics (19.9%, n = 31), AP chemistry (18.0%, n = 28), AP physics (14.7%, n = 23), and college chemistry (10.3%, n = 16). Of particular note is the fact that the respondents collectively took 752 advanced science and/or math courses, averaging 4.82 courses each.

Capstone course completion and enrollment in college STEM majors. Table 29 displays the binary logistic regression coefficients, the Wald tests, and odds ratios for each capstone course respondents indicated they had taken in Survey Question 18 (*"Which of the following science or math course(s) did you take in high school?"*) compared with Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*). Binary logistic regression was used to assess whether or not capstone course completion in math and/or science significantly predicted the frequency of the choice of a college STEM major. The capstone courses were blocked in groups of five and measured against dummy coded variables (0 = *not STEM major*, 1 = *STEM major*) retrieved from respondent answers to Survey Question 19, (*"What was your college major when you entered a university, college, or vocational school?"*). Only 134 of the 156 respondents were included in the analysis due to 25 respondents not having reported the necessary data to be included.

Table 29

Capstone Course Completion and Selection of College STEM Major Upon Entrance to College (n = 134)

Variables	*B*	SE-*B*	Wald	*df*	Sig.	Exp (*B*)	R^2
Block 1							.09
Anatomy & Physiology	**.79**	**.38**	**4.45**	**1**	**.04**	**2.2**	
AP Biology	.23	.38	.36	1	.55	1.3	
AP Chemistry	.12	.53	.05	1	.83	1.1	
College Chemistry	.77	.67	1.31	1	.25	2.2	
Honors Chemistry	.67	.38	3.13	1	.08	2.0	
Block 2							.16
AP Physics	.20	.48	.18	1	.67	1.2	
Honors Physics	**1.12**	**.46**	**5.86**	**1**	**.02**	**3.1**	
Calculus	.53	.51	1.07	1	.30	1.7	
Honors Calculus	.46	.47	.97	1	.33	1.6	
AP Calculus	.68	.43	2.62	1	.11	2.0	
Block 3							.15
College Algebra	-.86	.52	2.72	1	.10	.4	
Honors College Algebra	-.26	.52	.24	1	.62	.8	
AP Statistics	.21	.51	.17	1	.68	1.2	
Trigonometry	**1.57**	**.56**	**7.72**	**1**	**.01**	**4.8**	
Honors Trigonometry	**1.53**	**.52**	**8.77**	**1**	**.00**	**4.6**	

As shown in Table 29, anatomy and physiology, honors physics, trigonometry, and honors trigonometry showed a statistically significant relationship between capstone course completion and the selection of a college STEM major upon entrance to a university, college, or vocational school ($p < .05$).

Taking the Anatomy and Physiology course was a statistically significant predictor, -2 Log Likelihood = 1.72.37, χ^2 (1, n = 134) = 9.07, p = .04. The Nagelkerke pseudo R^2 = .09 indicated the model accounted for 9% of the total variance. Respondents who indicated they had taken anatomy and physiology while in high school were 2.2 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 30, the model was able to predict who would or would not choose a college STEM major with a 64.9% accuracy rate.

Taking the Honors Physics course was a statistically significant predictor, -2 Log Likelihood = 164.60, χ^2 (1, n = 134) = 16.85, p = .02. The Nagelkerke pseudo R^2 = .16 indicated the model accounted for 16 % of the total variance. Respondents who indicated they had taken honors physics while in high school were 3.1 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 30, the model was able to predict who would or would not choose a college STEM major with a 65.7% accuracy rate.

Taking the Trigonometry course was a statistically significant predictor, -2 Log Likelihood = 164.60, χ^2 (1, n = 134) = 16.85, p = .01. The Nagelkerke pseudo R^2 = .15 indicated the model accounted for 15 % of the total variance. Respondents who indicated they had taken trigonometry while in high school were 4.8 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 30, the model was able to predict who would or would not choose a college STEM major with a 64.2% accuracy rate.

Taking the Honors Trigonometry course was a statistically significant predictor, -2 Log Likelihood = 164.60, χ^2 (1, n = 134) = 16.85, p = .00. The Nagelkerke pseudo R^2 = .15 indicated the model accounted for 15 % of the total variance. Respondents who indicated they had taken honors trigonometry while in high school were 4.6 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 30, the model was able to predict who would or would not choose a college STEM major with a 64.2% accuracy rate.

Table 30 displays the percentages of cases (0 = *not STEM major*, 1= *STEM major*) that can be predicted by the model for the statistically significant predictors (anatomy & physiology, honors physics, trigonometry, and honors trigonometry). Average predictive percentages are in bold type for ease of reading.

Table 30

Accuracy Percentages for Predicting Selection of a College STEM Major Upon Entrance to College Based on Statistically Significant Capstone Courses Completed

Observed Variables		Predicted: College Major Non-STEM	Predicted: College Major STEM	Predicted: Percentage
Block 1				
Anatomy & Physiology	Non-STEM	65	14	82.3
	STEM	31	22	40.0
	Average Percentage			**64.9**
Block 2				
Honors Physics	Non-STEM	61	18	77.2
	STEM	28	27	49.1
	Average Percentage			**65.7**
Block 3				
Trigonometry				
Honors Trigonometry	Non-STEM	52	27	65.8
	STEM	21	14	61.8
	Average Percentage			**64.2**

As shown in Table 30, anatomy and physiology in Block 1 was able to predict who would or would not choose a college STEM major with a 64.9% accuracy rate. Honors physics in Block 2 was able to predict who would or would not choose a college STEM major with a 65.7% accuracy rate. Trigonometry and honors trigonometry in

Block 3 were able to predict who would or would not choose a college STEM major with a 64.2% accuracy rate.

Table 31 displays the binary logistic regression coefficients, the Wald tests, and odds ratios for each capstone course respondents indicated they had taken in Survey Question 18 (*"Which of the following science or math course(s) did you take in high school?"*) compared with Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*). Binary logistic regression was used to assess whether or not capstone course completion in math and/or science could significantly predict the frequency of the selection of a college STEM major. The capstone courses were blocked in groups of five and measured against dummy coded variables (0 = *not STEM major*, 1 = *STEM major*) retrieved from respondent answers to Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*). Only 128 of the 156 respondents answered this survey question. Statistically significant capstone courses are in bold type for ease of reading.

Table 31

Capstone Course Completion and Selection of Current College STEM Major (n = 128)

Variables	*B*	SE-*B*	Wald	*df*	Sig.	Exp (*B*)	R^2
Block 1							.07
Anatomy & Physiology	**.84**	**.39**	**4.54**	**1**	**.03**	**2.3**	
AP Biology	.29	.39	.56	1	.45	1.3	
AP Chemistry	.38	.53	.51	1	.48	1.5	
College Chemistry	.16	.70	.05	1	.82	1.2	
Honors Chemistry	.33	.39	.73	1	.39	.3	
Block 2							.16
AP Physics	-.61	.49	1.55	1	.21	.5	
Honors Physics	.92	.47	3.87	1	.05	2.5	
Calculus	.26	.55	.22	1	.64	1.3	
Honors Calculus	.35	.47	.55	1	.46	1.4	
AP Calculus	**.96**	**.44**	**4.81**	**1**	**.03**	**2.6**	
Block 3							.16
College Algebra	-.83	.54	2.38	1	.12	.4	
Honors College Algebra	-.20	.52	.16	1	.69	.8	
AP Statistics	.45	.51	.77	1	.38	1.6	
Trigonometry	**1.32**	**.58**	**5.28**	**1**	**.02**	**3.8**	
Honors Trigonometry	**1.57**	**.53**	**8.63**	**1**	**.00**	**4.8**	

As shown in Table 31, anatomy and physiology, AP calculus, trigonometry, and honors trigonometry showed a statistically significant relationship between capstone course completion and the selection of a college STEM major for those respondents currently enrolled or graduated from a university, college, or vocational school ($p < .05$).

Taking the Anatomy and Physiology course was a statistically significant predictor, -2 Log Likelihood = 161.92, χ^2 (1, n = 128) = 6.38, p = .03. The Nagelkerke pseudo R^2 = .07 indicated the model accounted for 7% of the total variance. Respondents who indicated they had taken anatomy and physiology while in high school were 2.3 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 32, the model was able to predict who would or would not choose a college STEM major with a 65.6% accuracy rate.

Taking the AP Calculus course was a statistically significant predictor, -2 Log Likelihood = 151.98, χ^2 (1, *n* = 128) = 16.32, *p* = .03. The Nagelkerke pseudo R^2 = .16 indicated the model accounted for 16 % of the total variance. Respondents who indicated they had taken AP calculus while in high school were 2.6 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 32, the model was able to predict who would or would not choose a college STEM major with a 70.3% accuracy rate.

Taking the Trigonometry course was a statistically significant predictor, -2 Log Likelihood = 152.51, χ^2 (1, *n* = 128) = 15.80, *p* = .02. The Nagelkerke pseudo R^2 = .16 indicated the model accounted for 16 % of the total variance. Respondents who indicated they had taken trigonometry while in high school were 3.8 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 32, the model was able to predict who would or would not choose a college STEM major with a 68% accuracy rate.

Taking the Honors Trigonometry course was a statistically significant predictor, -2 Log Likelihood = 152.51, χ^2 (1, *n* = 128) = 15.80, *p* = .00. The Nagelkerke pseudo R^2 = .16 indicated the model accounted for 16 % of the total variance. Respondents who indicated they had taken honors trigonometry while in high school were 4.8 times more likely to major in a STEM field than those respondents who did not take the course. As shown in Table 32, the model was able to predict who would or would not choose a college STEM major with a 68% accuracy rate.

Table 32 displays the percentages of cases (0 = *not STEM major*, 1= *STEM major*) that can be predicted by the model for the statistically significant predictors (anatomy & physiology, AP calculus, trigonometry, and honors trigonometry). Average predictive percentages are in bold type for ease of reading.

Table 32

Accuracy Percentages for Predicting Selection of Current College STEM Major Based on Statistically Significant Capstone Courses Completed

Observed Variables		Predicted: College Major Non-STEM	Predicted: College Major STEM	Predicted: Percentage
Block 1				
Anatomy & Physiology	Non-STEM	74	7	91.4
	STEM	37	10	21.3
	Average Percentage			**65.6**
Block 2				
AP Calculus	Non-STEM	73	8	90.1
	STEM	30	17	36.2
	Average Percentage			**70.3**
Block 3				
Trigonometry Honors Trigonometry	Non-STEM	68	13	84.0
	STEM	28	19	40.4
	Average Percentage			**68.0**

As shown in Table 32, anatomy and physiology in Block 1 was able to predict who would or would not choose a college STEM major with a 65.6% accuracy rate. AP calculus in Block 2 was able to predict who would or would not choose a college STEM major with a 70.3% accuracy rate. Trigonometry and honors trigonometry in Block 3 were able to predict who would or would not choose a college STEM major with a 68.0% accuracy rate.

Change of College Major

Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*), Survey Question 21 (*"Did you change your major?"*), and Survey Question 23 (*"What is your college major now? Or if you have graduated, what was your college major?"*) were analyzed to determine whether or not a change of college major affected selection of a college STEM major or non-STEM major. Table 33 displays the data indicating whether or not a respondent changed college major and if the respondent was a college STEM major or non-STEM major. STEM majors are in bold type for ease of reading.

Table 33

College Major Change and College Major Selection (STEM vs. Non-STEM)

Change Major (Q21) *n* = 156			College Major (Q19, Entering) *n* = 134				College Major (Q23, Now) *n* = 128			
			STEM		Non-STEM		**STEM**		Non-STEM	
	n	%	***n***	**%**	*n*	%	***n***	**%**	*n*	%
Yes	74	47.3	**28**	**40.6**	41	59.4	**19**	**30.2**	44	69.8
No	82	52.7	**27**	**41.5**	38	58.5	**28**	**43.1**	37	56.9
Total	156	100	**55**	**41**	79	59	**47**	**36.7**	81	63.3

In response to Survey Question 21 (*"Did you change your major?"*), 47.3% (*n* = 74) of respondents indicated that they had changed majors, and 52.7% (*n* = 82) of the respondents indicated that they had not changed majors. Table 33 shows that as incoming college freshman, 41% (*n* = 55) of respondents indicated that they chose a college STEM major, and 59% (n = 79) of respondents indicated that they chose a college non-STEM major. Of the respondents who were currently enrolled in college or had graduated, 36.7% (*n* = 47) of respondents indicated that they chose a college STEM major, and 63.3% (n = 81) of respondents indicated that they chose a college non-STEM major.

As shown in Table 33, 40.6% (*n* = 28) of respondents who had changed their major at some point in their college careers indicated that they were enrolled in college STEM majors as entering freshmen, and 59.4% (*n* = 41) of respondents who had changed their major at some point in their college career indicated that they were not enrolled in college STEM majors as entering freshmen. For respondents who did not change their college majors at some point in their college career, 41.5% (*n* = 27) of respondents indicated that they were enrolled in college STEM majors as entering freshmen, and 58.5% (*n* = 38) of respondents indicated that they were not enrolled in college STEM majors as entering freshmen.

As shown in Table 33, 30.2% (*n* = 19) of respondents who had changed their major at some point in their college career and were currently enrolled in college or had graduated indicated that they were or had been enrolled in college STEM majors, and 69.8% (*n* = 44) of respondents who had changed their major at some point in their college career and were currently enrolled in college or had graduated indicated that they were not or had not been enrolled in college STEM majors. For respondents who did not change their college majors and were currently enrolled in college or had graduated, 43.1% (*n* = 28) of respondents indicated that they were or had been enrolled in college STEM majors, and 56.9% (*n* = 37) of respondents indicated that they were not or had not been enrolled in college STEM majors.

A chi-square analysis was used to determine if a relationship existed between college major selected (STEM or non-STEM) when respondents first entered college or were currently enrolled in college or had graduated and change of college major. Table 34 displays the scores, degrees of freedom, and significance for respondents as entering college freshman and as currently enrolled or having graduated from college.

Table 34

Change of College Major as Predictor of College STEM Major Choice

Variable	Score	*df*	*p*
Q19 (Entering)	.01	1	.91
Q23 (Now)	2.30	1	.13

As shown in Table 34, the chi-square analysis indicated that there was no statistical significance for a respondent changing college major based on the college major selected when a respondent first entered college (STEM or non-STEM), χ^2 (1, n = 134) = .01, p = .91. The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A p value of .91 means that there was a 91% probability that any deviation from the expected number of respondents who selected a college STEM major or non-STEM major was due to chance alone. Changing a college major from the major first selected by respondents upon college entrance was not a determining factor in choosing a STEM major in college.

As shown in Table 34, the chi-square analysis indicated that there was no statistical significance for a respondent changing college major based on the college major selected while the respondent was currently enrolled in college (STEM or non-STEM), χ^2 (1, n = 128) = 2.30, p = .13. The observed chi-square was not significantly different from the expected result at the $p < .05$ level. A *p* value of .13 means that there was a 13% probability that any deviation from the expected number of respondents who selected a STEM major or non-STEM major was due to chance alone. Changing a college major by respondents who were currently enrolled in college was not a determining factor in choosing a STEM major in college.

Both Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*) and Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*) were compared with Survey Question 21 (*"Did you change your major?"*) to determine if respondents changed into or out of college STEM majors. Table 35 displays the score, degrees of freedom, and significance of this comparison.

Table 35

Change of College Major as Predictor of College STEM Major Choice Comparing Survey Questions 19 and 23

Variable	Score	*df*	*p*
Q19 (Entering) Compared to Q23 (Now)	70.40	1	.00

The chi-square analysis was statistically significant, χ^2 (1, *n* = 128) = 70.40, *p* = .00. The observed chi-square was significantly different from the expected result at the $p < .05$ level. A *p* value of .00 means that there was a 0% probability that any deviation from the expected number of respondents who changed into or out of college STEM majors was due to chance alone.

Analysis indicated that respondents tended to finish in the college major (STEM or non-STEM) where they began. Respondents who were STEM majors changed their majors but still remained STEM majors, while respondents who were non-STEM majors changed majors but remained non-STEM majors. Respondents who were STEM majors were slightly less likely to change majors than were non-STEM majors. Table 36 displays the college major selection (STEM or non-STEM) of respondents who changed their college majors and the frequency of major changes.

Table 36

College Major Selection of Respondents Who Changed Their Majors

	STEM		Non-STEM		Changed Major Once		Changed Major Twice		Changed Major Three Times	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Changed Major	15	26.8	41	73.2	30	53.6	22	39.3	4	7.1

Survey Question 22 ("*If yes, list all of your college majors*") served as a follow-up question to Survey Question 21 (*"Did you change your major?"*). Of the 74 respondents who indicated they had changed their major, 75.7% (*n* = 56) of respondents answered Survey Question 22. The respondents' answers to Survey Question 22 were matched with the respondents' answers to Survey Question 21. As shown in Table 36, of the 56 respondents to Survey Question 22, 26.8% (*n* = 15) respondents indicated choosing a college STEM major, and 73.2% (*n* = 41) of respondents indicated choosing a college non-STEM major. Some of the respondents (7.1%, *n* = 4) reported changing their major three times, 39.3% (*n* = 22) of respondents reported changing their major twice, and 53.6% (*n* = 30) of respondents reported changing their major once.

Summary

The relationship between factors that influenced choice of a college major (parental advice, SAT/ACT scores, capstone course(s) completion, advanced placement course(s), job shadow experience(s), peer (friend) recommendation, employment while in high school, school counselor advice, and personal experience) was compared to choosing or not choosing a college STEM major. There was no statistical significance found for self-reported decision factors and their influence on choice of a college STEM major.

The relationship between high school graduates with rigorous academic records and capstone course completion (anatomy and physiology, AP biology, AP chemistry, college chemistry, honors chemistry, AP physics, honors physics, calculus, honors calculus, AP calculus, college algebra, honors college algebra, AP statistics, trigonometry, and honors trigonometry) was studied through use of binary logistic regression. A statistically significant relationship was found between anatomy and physiology, honors physics, AP calculus, trigonometry, and honors trigonometry and respondents' choice of a college STEM major.

Using chi-square analysis, selection of a college STEM major or non-STEM major upon entrance to college and while currently attending or upon graduation from college were compared to determine if a statistically significant relationship existed. There was no statistically significant relationship found for respondents entering college as freshmen or for respondents who currently attend college or had graduated and selecting a college STEM major.

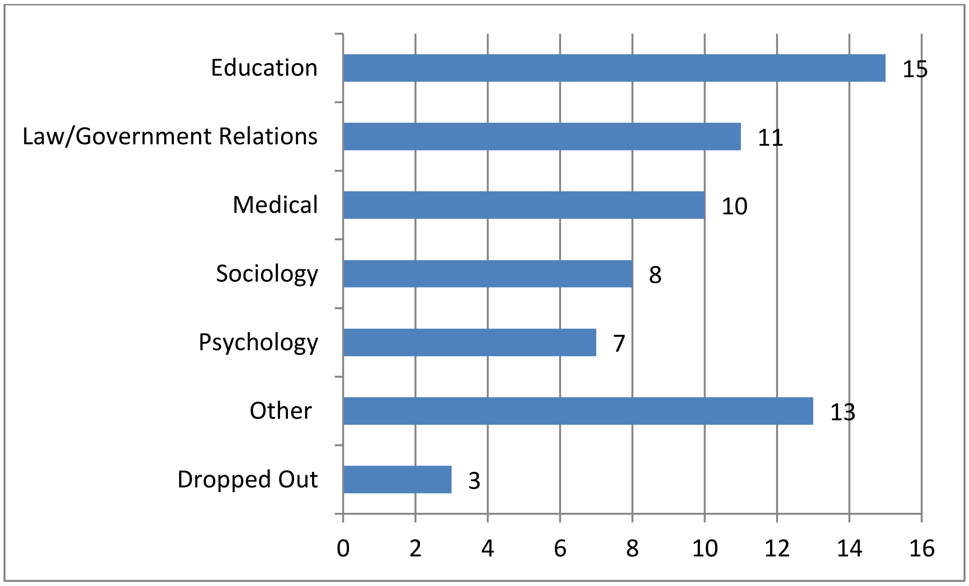
The relationship between college major choice (STEM or non-STEM) and change of a college major was statistically significant. Chi-square analysis indicated that respondents tended to finish in the college major (STEM or non-STEM) where they began.

Other Findings

Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*), Survey Question 22 (*"If yes, list all your college majors."*), Survey Question 23 (*"What is your college major now? Or if you have graduated, what was your college major?"*) Survey Question 24 ("*If you did not choose a science, technology, engineering, or math (STEM) major, why not?")*, and Survey Question 25 *("Please include any additional comments you may have about college major choice."*) were open-ended and offered respondents an opportunity to provide extra information in short answers.

The 67 responses of participants who answered Survey Question 24 (*"If you did not choose a science, technology, engineering, or math (STEM) major, why not?"*) were matched with their responses to Survey Question 23 (*"What is your college major now? Or if you have graduated, what was your college major?"*). Figure 5 displays the college majors of the respondents to Survey Question 23 who also answered Survey Question 24.

Figure 5. Self-Reported Majors of Survey Respondents Who Did Not Major in STEM



As shown in Figure 5, of the 67 survey respondents to Survey Question 24, 22.4% (*n* = 15) indicated that they had chosen majors in education, and 16.4% (*n* = 11) indicated that they had chosen law or government relations majors. The respondents (19.4%, *n* = 13) grouped in the "*other*" major category selected majors that ranged from anthropology to music performance; 4.5% (*n* = 3) of the respondents indicated that they had dropped out of college.

Analysis of Comments

All of the respondents to Survey Questions 24 (*"If you did not choose a science, technology, engineering, or math (STEM) major, why not?"*) were Caucasian/White American with 83.6% (*n* = 56) of the responses from females and 14.9% (*n* = 10) of the responses from males. One respondent did not answer the query regarding sex. Of the 156 respondents to the study survey, 14.1% (*n* = 22) of respondents chose to comment on Survey Question 25 (*"Please include any additional comments you may have about* *college major choice."*). The majority of respondents to Survey Question 25 indicated that they were female (77.3%, n = 17).

Responses to Survey Questions 24 and 25 were sorted manually by the researcher. Each response was reviewed to identify themes and patterns. A comprehensive list of potential themes was then developed by the researcher; initial review identified eight topics that were repeated: aversion, interest, lack of ability, difficulty, enjoyment, time, success, and haste. From the initial list of eight topics, several initial themes were identified to be smaller parts of larger themes. For example, the initial topic "lack of ability" was discovered to relate to the topic "difficulty." The inductive analysis of the comments from Survey Question 24 ("*If you did not choose a science, technology, engineering, or math (STEM) major, why not*?") and Survey Question 25 (*"Please include any additional comments you may have about college major choice."*) yielded four broad themes: (1) lack of interest, (2) difficulty, (3) aversion, and (4) lack of time. These four themes captured the depth and range of experiences shared by the respondents.

Theme 1: Lack of Interest. The first theme that emerged was that respondents were just not interested in a STEM major or career. Respondents indicated a distinct lack of interest in the subjects and content taught in STEM and the possible careers to which STEM majors could lead. Six respondents indicated that having a STEM major or taking science, technology, engineering, or math classes was of "no interest" or "not a field that interested me." Other respondents commented:

"Not what I wanted to do."

"It wasn't a good fit to my personality."

“Physical therapy interests me more than those.”

“Because I am tired of taking those classes.”

Longer responses offered a more in-depth rationale for students choosing to not major in STEM fields:

“Language and culture classes interest me more [than] STEM courses would, and I chose a teaching field that offered classes I knew I would enjoy.”

“Not my area of interest. Plus, the few classes I did take were dry and extremely difficult so I found them inaccessible.”

“I’m not interested in any of those [STEM] fields to focus solely on them.”

“I wasn’t interested in doing so, as well as unsure what job opportunities such a major would provide me.”

“I wasn’t interested in becoming an engineer. I liked my math and science classes in high school, but I prefer the creativity of advertising and journalism. Nuclear engineering crossed my mind, but I wasn’t passionate about it. I love my major now.”

“Not especially interested in the career choices it offers. I would have done fine with the classes, but I could never find a practical application (career) that I felt I would enjoy for the next 40 years of my life.”

“Well, anthropology isn’t always classified as a hard science, but many aspects (including physical anthropology) should be. Much of the field falls more in the social science category. I did not choose a more traditional STEM field because I was not interested in engineering or mathematics or other science fields, perhaps with the exception of biology, which I did consider for a time.”

"It held no interest to me in the end. We need more people in the arts and helping professions, but they tend to get ignored. I will use math in my chosen major, and that is good enough for me."

Theme 2: Difficulty. Eleven respondents indicated that STEM majors were just "too hard." Other respondents indicated the following:

"[I] did not think I would succeed, and I was passionate about social sciences."

"[I] don't have the aptitude or the interest."

"My major [is] easier."

A few respondents indicated that the skills in math and science they had obtained in high school were not sufficient to succeed in a college STEM major by saying, "did not think I would succeed." Others wrote:

"I am not good at science, technology, engineering, or math. They were my worst subjects in high school."

"My math is only so-so. All those majors rely on math or at least share similar principles with it."

"The science and math courses involved at my alma mater were very difficult and I didn't see applicability to a job I would want."

"I have wanted to be a psychologist for as long as I can remember. I also never felt that math and science were my strongest subjects."

"Although I am very good at math, I am terrible at science. Never understood it and wasn't taught sufficiently in it before college so I was already behind even in 101 science courses."

“STEM majors are probably the most difficult to pursue and certainly require a much larger time commitment to academics than most other degree options; but at this point they are necessary to acquire an innovative and financially sound job.”

Theme 3: Aversion. The respondents’ answers that fell into this theme were very passionate. Comments like “I hate math and science” were expressed by four respondents. Other respondents stated:

“Disliked labs with no windows.”

“Because it is hard for me to comprehend deeply.”

“It is not something that brings me satisfaction, and I have no passion for the subjects; interested in creativity and liberal arts.”

“I am not good at science, technology, engineering, or math.”

“I stopped enjoying math at the end of high school, and I wanted to choose something I really liked rather than something that felt like too much work.”

“I wanted to be a teacher more. I didn’t enjoy my science classes that much.”

One respondent summed up the feelings of all the individuals whose responses fit into this theme:

“I do not enjoy science or math and did not want to have a career focused around those subjects.”

The following comment was from a respondent who chose to drop out of college:

“Youth are recommended to have an interest in the sciences and mathematics, but it not a skill that everyone needs or can sustain. I think there is a heavy cultural focus on university and college graduation, and I agree that a structured education is a must. But, we would find other routes such as private mentorships, apprenticeship and entrepreneurship to be a more qualifying preparation for some goals. I chose to study something that was relative to my own nature and interest, but I realized the university/college major and system was not structured in an efficient manner for [me] to reach these goals. The benefits did not outweigh the cost in time, debt, and effort, so I resigned."

Theme 4: Lack of Time. The respondents in this theme had one goal in mind--to complete college in the least amount of time possible without regard to major choice or career options. "[I chose the] major I could complete the fastest" was the comment made by the majority of respondents. Others stated:

"I am better at writing, and I had more dual enrollment and AP credits that would help me graduate from college in only 5 semesters, so I chose the quickest route to getting my degree."

"I would have done some form of ecology if music did not take up so much of my time."

Three respondents did not consider college majors or occupations in the health professions to be STEM related. These respondents stated:

"Not a requirement for what I am going into. Degree is earned after completing nursing course."

"Had interest in nursing."

"I am interested in working in the health field and interacting with people who need my help."

Other comments. Other responses from respondents who selected a STEM major are as follows:

“What really helped me choose my major were my undergraduate classes. They helped me to see what was out there and experience what it would be like to have different majors.”

“Biochemistry allowed a variety of courses in both chemistry and biology. The versatility of a biochemistry degree, with options for chemistry, biology, or even health science careers, was a major factor in my decision making as a freshman. By having a variety of options, I could experience different fields and narrow it down during my undergraduate career.”

“If your degree isn’t a STEM, it’s a waste of money, generally speaking.”

“I wish there was more jobs available for students that don’t get a master’s in science.”

“Another big factor was predicted income. Medicine wins there.”

“Engineering is awesome! Even for girls. :)”

“Taking art history in high school completely changed my outlook on life. I was always very attached to the sciences but thoroughly enjoyed the arts. Then I took a writing-art history course in college and was heartbroken to think that I would only be taking math-science courses. Then I realized if double majored (neuroscience & art history), I could have a focused path on which classes to take and would be able to prioritize the study of art in my life. Majoring in art history gave me a reason to study abroad in Paris and get involved with the college museum. It also gave me access to professors who understood me in a way that my science professors just didn’t or couldn’t. Because I chose two majors with some of the most graduation requirements (but did actually fulfill all of the distribution requirements), I did need some help from the department head. An interim head suggested that I just minor, because I was one class short and I almost lost it. Luckily, the head of the department returned and enabled me to do both."

Respondents who did not select a STEM college major made the following comments:

"Students need to be exposed to many choices and paths before they settle on one. Math and science are great choices but they are not the only focus or choice."

"I think it is important for people who are good at math and science to bring their talents and knowledge to all career areas."

"I believe young adults should be introduced to career paths at mainstream institutions and pathways independent of university/college degree programs. People need something that will sustain them with a wholesome satisfying career."

"I think it is important to do what you love. We live in a time where you can make money doing what you love. You don't have to be a factory worker. You can be almost anything you want to be and are interested in."

"Do what you love."

It is perhaps notable that students who had chosen STEM majors responded to this survey question with a definite bias toward STEM while non-STEM majors felt that STEM majors and traditional college education were not essential or even necessary for future career goals.

Summary

The data generated from the 156 respondents who completed the survey produced an array of significant and non-significant results. Respondents were found to be more likely to pursue college STEM majors if they exhibited high STEM self-efficacy. As far as what influenced high school graduates with rigorous academic records to choose or not choose STEM majors in college, enrollment in anatomy and physiology, honors physics, AP calculus, trigonometry, and/or honors trigonometry of survey respondents had a direct relationship. Analysis of the data from the study survey indicated a statistical significance between choice of a college major both when entering college and while in college and changing of the respondents' college major. The data indicated that respondents who began college in a STEM major stayed in a STEM major, even if a change of major occurred.

The comments served to clarify, expand, and contextualize the meaning despite a lack of statistically significant results. While analyses of many of the variables revealed no statistical significance for choosing or not choosing a STEM college major, the comments showed individual implications. It appears that college STEM major choice may be based more on skills and individual experience than the literature suggests.

Chapter V discusses the results and provides conclusions, recommendations, and suggestions for future research.

CHAPTER V

Summary, Discussion, Conclusions and Recommendations

Choice of an academic major influences the courses a student must take to complete a degree and has a profound effect on the career path that is pursued after graduation. Many of the "best and brightest" students in America are shunning STEM majors. The point in the STEM pipeline where the highest losses occur is between high school graduation and college entry.

The purpose of this study was to explore the factors that influence graduates from three high schools in southern Idaho, who complete a rigorous high school academic program, to choose or not choose STEM majors in college. The study was guided by the following research questions:

1. What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?
2. What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?
3. What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

This chapter will discuss the results relative to respondent demographics and each research question in order. Overall conclusions and recommendations for future research follow the summary and discussion.

Summary and Discussion

Participants in this study were high school graduates of 2010, 2011, and 2012 from three public high schools in a school district in southern Idaho. Of the 553 survey invitations emailed, 156 (30.4%) of the recent high school graduates who were invited to participate in the study completed the survey. The survey was administered during the month of April, starting right after spring break. It is possible that the response rate to the survey was negatively affected by administering the survey at this point in the semester due to the increasing workload associated with the last few weeks of an academic semester.

The gender representation of the respondents to the study survey was not an accurate representation of the selected study population (academic honors students). The numbers of potential respondents were 57% (*n* = 316) females and 43% (*n* =237) males. Females comprised 73.7% (*n* = 115) of the respondents, and males comprised 26.3% (*n* = 41) of the respondents to the study. It is unknown why a greater number of females than males responded to the survey.

The vast majority of the respondents (94.2%) were Caucasian/White American. This number is an accurate reflection of the actual demographic for the state of Idaho, the county where the study schools are located, and the study schools where over 86% of students are Caucasian/White American (United States Census Bureau, 2014a, 2014b).

As reported by participants, their fathers (59.61%) and mothers (51.27%) had obtained at least a bachelor’s degree as the highest education level reported. All parents of all respondents (100%) had obtained at least a high school diploma or the equivalent. This high number is probably due to several factors, including the fact that the county where the study schools are located is home to a university, that the people in this county in Idaho tend to be more highly educated than the general population of Idaho, and that the study respondents were from the top 23.2% of all high school students graduating from this county in the study years of 2010, 2011, and 2012. This group of respondents was specifically selected based on the likelihood that they would attain higher education. Highly motivated students are likely to have parents who value and have attained higher education themselves.

The median income of the parents of the respondents in this study was reported to be in the $80,000 to $99,999 range. These respondents came from homes where the parents were highly educated and probably had high paying jobs. There is the possibility that since 17.3% (n = 27) of the respondents admitted they did not know their parents' household income, many other respondents just guessed, possibly causing the median income statistic to be inflated.

Although these demographic comparisons may be interesting, the purpose for gathering the demographic data of the respondents was not to generalize the findings to the school district, county, state, or nation at large but, rather, to determine whether or not significant relationships exist between demographics and the choice of a college STEM major.

Research Question 1: What is the relationship between selected demographic variables of recent high school graduates and choice of a college STEM major?

There were no statistically significant relationships between any of the selected demographics of the respondents and their choice of a college STEM major.

Because of the small sample size in this study, the results cannot be generalized beyond the population of the study. It is possible that there was a demographic relationship, but the study lacked sufficient power to detect the relationship because of the small sample size. For example, being male is known to be a consistent predictor of college STEM major selection (Halpern, et al., 2007). This study showed no statistically significant results for sex as a predictor of college STEM major selection. It would be a mistake to assume that sex has no impact on college STEM major selection. It is more likely that this study lacked the power to show the effect. A larger study of this type could show different results for all demographics simply because of increased statistical power.

In summary, while there were no statistically significant relationship between any demographic and the respondents' decision to choose or not choose a college STEM major, these data still yielded interesting insights. The fact that no significant differences were found for the demographic variables in relation to college STEM major choice may imply that college major choice may transcend sex, ethnicity, parents' highest educational level, and parents' total income. This implication allows the study to focus on the significance and predictive magnitude of self-efficacy, factors influencing choice of a college STEM major, and capstone course completion.

Research Question 2: What is the relationship between self-efficacy and factors influencing recent high school graduates about their choice of a college STEM major?

Binary logistic regression was used to assess whether or not measures of self-efficacy in math and/or science significantly predicted the frequency of the selection of a college STEM major. The self-efficacy questions were measured against respondent answers to Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*). The statistically significant questions were Survey Questions 4, 9, and 10:

Survey Question 4: (*"Doing well at* ***science*** *will enhance my career/job opportunities."*)

Survey Question 9: (*"I think I will succeed (earn an A or B) in my* ***math*** *courses."*)

Survey Question 10: (*"Doing well at* ***math*** *will enhance my career/job opportunities."*)

Therefore, respondents who indicated that they thought they would succeed in math courses and that doing well in science and math would enhance their career/job opportunities were more likely to choose a college STEM major. These findings agreed with much of the literature addressing self-efficacy and STEM college majors (AAUW, 2004; Andrew, 1998; DeBacker & Nelson, 2000; Heilbronner, 2011; Weisgram & Bigler, 2007.)

Chi-square analyses were conducted to compare the statistically significant self-efficacy questions (Survey Questions 4, 9, and 10) and the factors that influenced college major selection (parental advice, SAT/ACT scores, capstone course(s), Advanced Placement course(s), job shadow experience, peer recommendation, employment in high school, school counselor advice, and personal experience). There were no statistically significant relationships between any of the factors that influenced choice of a college major and self-efficacy Survey Questions 4, 9, and 10.

In summary, when examining respondents' self-efficacy only, the three significant math and science self-efficacy questions (Survey Questions 4, 9, and 10) identified a relationship between self-efficacy and choice of a college STEM major.

When comparing self-efficacy and the nine factors that influence choice of a college major, no relationship was found. Although the relationship between math and science self-efficacy and factors that influenced choice of a college STEM major was not found to be statistically significant, additional relationships were explored as part of the next research question.

Research Question 3: What influences recent high school graduates with rigorous academic records to choose or not choose STEM majors in college?

Comparisons were made between nine factors that influenced college major decisions (parental advice, SAT/ACT scores, capstone course(s), Advanced Placement course(s), job shadow experience, peer recommendation, employment in high school, school counselor advice, and personal experience) and both Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*) and Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*), using binary logistic regression analyses. The purpose of conducting these statistical tests was to see if there was a difference between the respondents' choice of a college major upon entrance to a university, college, or vocational school (Survey Question 19) and current or graduated respondents' choice of a college major (Survey Question 23) in regard to the nine factors included in the survey that could influence choice of a college STEM major.

There was no statistically significant relationship found between the factors that influenced college major selection and the selection of a college STEM major. Even though a large number (entering college = 61.2%; now = 62.5%) of respondents identified a "personal experience" as the factor that influenced their choice of a college

STEM major, the relationship was not statistically significant. Due to the fact that nine tests per survey question were being run, an adjusted α (p <.005) was calculated to offset the possibility of a false positive.

Capstone course completion as part of a rigorous academic record in high school was studied to determine if capstone course completion in math and science influenced the choice of a college STEM major. Rigorous academic records or coursework were defined as dual-credit, advanced placement, or honors coursework while enrolled in a high school (Medhanie & Vanden Berk, 2013). A capstone course was defined as an advanced course coming at the end of a sequence of courses with the specific objective of integrating a body of relatively fragmented knowledge into a unified whole (Durel, 1993).

Binary logistic regression analyses were conducted to determine if capstone course completion in math and science while in high school influenced the choice of a college STEM major. The capstone course measures were blocked into groups of five and measured against Survey Question 19 (*"What was your college major when you entered a university, college, or vocational school?"*). A statistically significant relationship was found between completion of anatomy and physiology, honors physics, trigonometry, and honors trigonometry and the choice of a college STEM major upon entrance to a university, college, or vocational school ($p < .05$).

Next, the capstone course measures were blocked into groups of five and measured against Survey Question 23 (*"What is your college major now? Or, if you have graduated, what was your college major?"*). A statistically significant relationship was found between completion of anatomy and physiology, AP calculus, trigonometry, and honors trigonometry and the choice of a college STEM major while currently enrolled in college ($p < .05$).

The results of analyzing the significance of the relationship between capstone course completion and choice of a major upon college entrance and current major were very similar. Honors physics, anatomy and physiology, trigonometry, and honors trigonometry were all found to be significant indicators of their choice of a college STEM major upon college entrance. AP calculus, anatomy and physiology, trigonometry, and honors trigonometry were found to be significant indicators of choice of a college STEM major later in the respondents' college career.

Also studied was whether or not respondents had changed majors and if their majors were in a STEM disciplines or not. Seventy-four (47.3%) of the respondents indicated that they had changed majors, and 82 (52.7%) of the respondents indicated that they had not changed majors.

Both Survey Questions 19 and 23 were compared with Survey Question #21 (*"Did you change your major?"*) to determine if respondents changed into or out of college STEM majors. The chi-square analysis indicated that respondents tended to finish in the college major (STEM or non-STEM) where they began. Respondents who were STEM majors changed their majors but still remained STEM majors, while respondents who were non-STEM majors changed majors but remained non-STEM majors. Respondents who were STEM majors were slightly less likely to change majors than were non-STEM majors.

In summary, the nine college major decision factors (parental advice, SAT/ACT scores, capstone course(s), Advanced Placement course(s), job shadow experience, peer recommendation, employment in high school, school counselor advice, and personal experience) had no statistically significant influence for selection of college STEM major. However, completion of specific capstone courses (anatomy and physiology, honors physics, AP calculus, trigonometry, and honors trigonometry) did have a statistically significant relationship on choice of a college STEM major. Respondents who started in STEM (or non-STEM) majors stayed in STEM (or non-STEM) majors even if they changed majors.

While this study was not qualitative, the narratives proved to be very useful in expanding and contextualizing the quantitative findings. There seemed to be a distinct difference between the responses from those respondents who had selected college STEM majors and those who had selected non-STEM majors. Respondents who had chosen college STEM majors responded with a definite bias toward STEM while non-STEM majors expressed that college STEM majors were not essential or even necessary for future career goals. Several respondents' comments were negative, if not downright hostile, toward science, technology, engineering, and math courses and college majors. The responses also highlighted reasons for choosing or not choosing a college STEM major based on interest, difficulty of the STEM subjects, the time it took to complete college STEM majors, and differences between males and females regarding college STEM major selection.

The respondents who offered comments had a wide variety of college majors. While the factors influencing choosing or not choosing a STEM major were not shown to be statistically significant, many of the comments showed that these decision factors did have an impact on individual students. One respondent whose response directly addressed the relationship between college decision factors and choice of a college major wrote, “It was a tough choice for me, mostly because I feel there are so many good options out there. I had a difficult time narrowing it down. My co-workers had a big influence on my choice of major.”

In summary, lack of self-efficacy in math and science was frequently cited for not choosing a college STEM major. Based on the their statements, respondents did not find STEM interesting, thought college STEM majors were too difficult, did not like STEM subjects, and thought it would take too much time to complete a college STEM major.

Conclusions

The findings of this study brought to light factors that influenced graduates from three high schools in southern Idaho, who completed a rigorous high school academic program, to choose or not choose STEM majors in college.

- There are few studies focused specifically on analyzing multiple factors that can contribute to a student’s choice of a college STEM major. No one study has attempted to analyze multiple factors and draw conclusions that may be useful in encouraging students to enter and stay in the STEM pipeline. This study was designed to address this gap in empirical knowledge.
- Selected demographics have no influence on choice of a college STEM major. Based on the survey responses, no statistical relationship exists between sex, etc. and the choice of a college STEM or non-STEM major. This may be attributed to the low response rate to the study survey.

- Self-efficacy in math and science has an influence on choice of a college STEM major. Self-efficacy in math and science has a statistically significant relationship with choice of a college STEM major. The statistical analyses of the survey questions revealed that respondents were found to be more likely to pursue college STEM majors if they exhibited high self-efficacy in science and/or math.
- Respondents may not understand what influenced their choice of a college major, or they were influenced by a variety of factors so that no one factor was more or most important.
- Completing selected capstone courses in high school indicate likelihood of enrollment in a college STEM major. Enrollment in anatomy and physiology, honors physics, AP calculus, honors trigonometry, or trigonometry were indicators of college STEM major selection.
- Students who begin college in STEM majors stay in STEM majors. It is important to make sure that students begin college in a STEM major if losses from the STEM pipeline are to be decreased. Respondents tended to finish in the college major (STEM or non-STEM) where they began. Respondents who were college STEM majors changed their major but still remained STEM majors, while respondents who were non-STEM majors changed majors but remained non-STEM majors.

Recommendations for Application of Study Findings

The information gathered from this study provides foundational support for recommendations to increase retention of high school graduates in the STEM pipeline, thereby expanding the numbers of college freshmen who choose a college STEM major. The recommendations will be drawn from both the quantitative data and the analyses of the responses to the open-ended survey questions. This evidence, as well as pertinent points highlighted in the literature, provides the basis for specific recommendations.

- High school students should be encouraged to complete capstone courses especially in anatomy and physiology, AP calculus, honors physics, trigonometry, and honors trigonometry. Students in high school may or may not be aware of the course offerings. Science and math teachers, as well as school counselors and parents, need to become more proactive in encouraging students to take these courses and in making capstone courses more appealing to students.
- Based upon the responses to the open-ended questions, high schools should offer STEM activities, science fairs, clubs, classes, and/or guest speakers more frequently to provide students with a personal math or science experience. Competitions and opportunities for high school students to meet STEM researchers and experience STEM careers could be beneficial.
- Additional labs infusing real world application could be included in the science and math curricula to increase student STEM self-efficacy.
- Proactive attempts to raise student awareness of STEM courses, college majors, and careers throughout a student’s academic career could serve to promote increased student STEM interest and thereby increased college STEM major selection.

- Universities need to increase their support of STEM courses at the high school level. Opportunities for mentoring, involving students in research, and informing students and their parents of the interesting research and activities that the STEM major students and STEM faculty are involved in could increase the selection of a college STEM major by the high school student.
- Employers should become more involved with the students at the high school level. Opportunities to sponsor field trips, be guest speakers, or provide a work experience site would likely increase selection of a college STEM major.

Recommendations for Further Study

As this study progressed, some problems and a variety of prospects for further research presented themselves, as well as some questions that were beyond the scope of the study. These problems, opportunities, and questions are presented in the form of suggestions and relevant questions concerning future investigations of factors that influence the choice of a college STEM major.

- One of the most obvious problems with this study was the small sample size. A study of this type would benefit from having a larger sample. It may be meaningful to conduct this study (or a variation of it) by expanding it to a larger population (state-wide or national).
- Conducting the survey at a different time in the semester or for a longer duration may have been beneficial. The beginning of the semester appears to be a better time to survey than the end of the semester.

- The population in the current study was homogeneous, thus limiting the generalizability of the results. It would be valuable to conduct the same study among college or high school students representing a variety of demographics.
- Studying differences in high school attended and how many students from specific high schools continue to major in STEM at college would be interesting. Is there a difference in the selection of a college major among the respondents, depending upon the high school attended? Is there a difference among the respondents' selection of a college to attend, and thus, a college major selection, depending upon the high school attended?
- It would have been useful to determine if a parent's occupation was a factor in the respondent's college major selection. Interesting data might be obtained from determining if respondents are more likely to choose a college STEM major if a parent works in a STEM field.
- It would be valuable to detect if differences exist in college STEM major selection by respondents from single-parent homes versus two-parent homes.
- Differences in college STEM major selection by respondents who attend high school in urban settings versus rural settings would be interesting to study.
- The socioeconomic status of a respondent's family may impact his or her ability to go to college. Are there differences in STEM major selection (and college attendance) by respondents based on the annual income of their parents and a student's ability to receive financial aid for college attendance?

- A study to investigate if a determining factor in the decision making process for students to choose or not choose STEM majors in college is the potential for future earnings in STEM careers.
- Comparing the results of this study with the results of a similar study conducted among the following groups may reveal interesting and meaningful results:
    a. honor students identified by high school attended
    b. general population identified by high school attended
    c. men and women of college age but not currently enrolled in college
    d. men and women working in careers/jobs after college graduation
- The current study could be repeated to obtain trend data.
- A further study of co-curricular activities while in high school and during college and their relationship with college major selection could be undertaken. It would be interesting and meaningful to determine if athletics, clubs, and activities have any impact on the choice of a college STEM major.

In summary, choice of a STEM (science, technology, engineering, and math) major will help students achieve a broad understanding of the scientific and mathematical foundations of the natural and human-made worlds (National Research Council, 2011). As can be seen from reading the information presented, for America to remain the global innovation leader, the United States must make the most of all of the potential STEM talent this country has to offer. America met one historic challenge and went to the moon. Now America must meet another: increase students' self-efficacy in math and science, encourage high school students to take capstone courses in STEM, and fix the leak in the

STEM pipeline after high school graduation to keep America's best and brightest in STEM majors at the college level. America needs STEM-related talent to compete globally and will need even more in the future. It is not a matter of choice.

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APPENDIX A

College Major Choice Survey

College Major Choice: A Survey

1. Taking science courses will help me to keep my career options open.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

2. I can complete the science requirements for most college majors.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

3. I think I will succeed (earn an A or B) in my science courses.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

College Major Choice: A Survey

4. Doing well at science will enhance my career/job opportunities.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

5. A degree in a science discipline will allow me to get a job and use my talents and creativity.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

6. Doing well in science will increase my sense of self-worth.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

College Major Choice: A Survey

7. Taking math courses will help me to keep my career options open.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

8. I can complete the math requirements for most college majors.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

9. I think I will succeed (earn an A or B) in my math courses.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
○	○	○	○	○	○	○	○

College Major Choice: A Survey

10. Doing well at math will enhance my career/job opportunities.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
◯	◯	◯	◯	◯	◯	◯	◯

11. A degree in a math discipline will allow me to get a job and use my talents and creativity.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
◯	◯	◯	◯	◯	◯	◯	◯

12. Doing well in math will increase my sense of self-worth.

Strongly Disagree	Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Agree	Strongly Agree	Don't Know
◯	◯	◯	◯	◯	◯	◯	◯

College Major Choice: A Survey

13. Sex:

- ◯ Male
- ◯ Female

14. Race/Ethnicity:

- ◯ Black/African American
- ◯ American Indian/Alaskan Native
- ◯ Asian/Pacific American
- ◯ Latina/Latino/Hispanic American
- ◯ Caucasian/White American

Other (please specify)

[ ]

College Major Choice: A Survey

15. What is the highest degree or level of schooling your father completed?

- ○ I Don't Know
- ○ Not a high school graduate
- ○ High school graduate-high school diploma or the equivalent (i. e. GED)
- ○ Some college, no degree
- ○ Post-secondary certificate or license
- ○ Associate degree
- ○ Bachelor's degree
- ○ Master's degree
- ○ Professional or doctorate degree

16. What is the highest degree or level of schooling your mother completed?

- ○ I Don't Know
- ○ Not a high school graduate
- ○ High school graduate-high school diploma or the equivalent (i. e. GED)
- ○ Some college, no degree
- ○ Post-secondary certificate or license
- ○ Associate degree
- ○ Bachelor's degree
- ○ Master's degree
- ○ Professional or doctorate degree

College Major Choice: A Survey

17. What is your parents' total income?

- ◯ I Don't Know
- ◯ Less than $10,000
- ◯ $10,000 to $24,999
- ◯ $25,000 to $39,999
- ◯ $40,000 to $59,999
- ◯ $60,000 to $79,999
- ◯ $80,000 to $99,999
- ◯ $100,000 or more

College Major Choice: A Survey

18. Which of the following science or math course(s) did you take in high school? Check all those that apply.

- [ ] Anatomy & Physiology
- [ ] AP Biology
- [ ] AP Chemistry
- [ ] College Chemistry
- [ ] Honors Chemistry
- [ ] AP Physics
- [ ] Honors Physics
- [ ] Calculus
- [ ] Honors Calculus
- [ ] AP Calculus
- [ ] College Algebra
- [ ] Honors College Algebra
- [ ] AP Statistics
- [ ] Trigonometry
- [ ] Honors Trigonometry

College Major Choice: A Survey

19. What was your college major when you entered a university, college, or vocational school?

20. Which of the following factors contributed to your decision to select the major identified in question 19 above? Check all that apply.

- [ ] Parental advice
- [ ] SAT/ACT score
- [ ] Capstone course(s) in high school
- [ ] Advanced Placement (AP) course(s) in high school
- [ ] Job shadow experience in high school
- [ ] Peer (friend) recommendation
- [ ] Employment while in high school
- [ ] Advice of school counselor
- [ ] Personal experience (i.e. competing in a science fair at a young age sprked interest in rocket science)

Other (please specify)

College Major Choice: A Survey

21. Did you change your major?

- ◯ Yes
- ◯ No

22. If yes, list all of your college majors.

College Major Choice: A Survey

23. What is your college major now? Of, if you have graduated, what was your college major?

24. If you did not choose a science, technology, engineering, or math (STEM) major, why not?

College Major Choice: A Survey

25. Please include any additional comments you may have about college major choice.

APPENDIX B

Email Letter and Informed Consent

Dear Recent Pocatello/Chubbuck School District #25 Graduate:

I am inviting you to participate in a study that will be used for a doctoral dissertation in Educational Leadership at Idaho State University. You were selected for participation because of your outstanding academic record while a student in Pocatello/Chubbuck School District #25. Your responses are extremely important due to the limited number of students selected for this study.

The information gained in this research will help clarify why some students are choosing, or not choosing, science, technology, engineering, and math (STEM) majors in post-secondary education.

The findings of this study will be presented to other people, although no information identifying you or what high school you attended will be reported. Your participation is completely voluntary, and you will be anonymous. If you volunteer, you will be asked to fill out a short survey. The survey should take fewer than ten minutes to complete. Will you please take a few minutes to complete the survey? The link is provided here: https://www.surveymonkey.com/s/8FVJJJN. Please complete the survey within two weeks.

Thank you for your participation in this survey. Again, your input is extremely important for obtaining an accurate picture of the results. If you have any questions about this survey, please feel free to contact me at (208) 684-9240 or duffkand@isu.edu.

Kandi L. Duff

Informed Consent (located on the first page of the online survey)

College Major Choice: A Survey

Informed Consent

Participation in this study is voluntary and will not affect your relationship with your educational institution. The information that you provide will only be presented in aggregate form. Your answers will not identify you individually. You may withdraw your consent at any time and discontinue participation without penalty.

"I have read (or someone has read to me) the information provided above. I have been given an opportunity to ask questions, and all of my questions have been answered to my satisfaction. I certify that I am 18 years old or older, understand the statements above, and freely consent to participate in this study. By continuing with the survey, I give my consent to participate."