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BRIDGING THE OPPORTUNITY GAP: MOTIVATIONAL FACTORS FOR UNDERREPRESENTED MINORITIES IN STEM CAREERS

by

Francisco J. Alonso

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ABSTRACT

Over the last few decades, there has been a decline in the number and quality of skilled workers entering the Science, Technology, Engineering, and Mathematics (STEM) workforce. This employment shortage is predicted to create a national economic crisis that threatens to erode the global economic standing of the U.S. Although there has been an effort and attempt to address these issues by investing heavily in policies and programs, there seems to be a lack of accountability and effective validation in managing the multitude of programs funded across multiple agencies. In addition, it has been documented that we, as a society, have neglected to motivate and provide equitable opportunities to certain minority groups in the STEM workforce. This study aimed to investigate effective motivators that would encourage minority students to pursue careers in the STEM professions.

The target group for this mixed method study were members of the Science Technology Engineering and Mathematics (STEM) community, successful STEM practitioners and professionals. This study specifically focused on potentially qualified candidates that have been ignored or marginalized for many years, who may be the solution to the employment shortage problem. The data was primarily collected through a 24-item researcher-constructed survey which gathered information about the participants' educational and life experiences, especially those experiences that influenced and motivated them to pursue their STEM career. Using ANOVAs, the researcher found that parents, family, teachers, schools, and communities provided the highest influence on URMs' career decisions, as opposed to Non-URMs. The findings and motivational factors could be used to create and shape better and more effective policies aimed at focusing efforts and resources into programs that would motivate the highest number of Underrepresented Minorities (URMs) into STEM careers. These programs should not only be effective, but also be well-monitored, provide accountability, and ensure that the desired results are met in a timely

manner.

Keyword: STEM, motivation, mixed methods

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

Three years ago, several of us committed to entering the Doctorate in Educational Leadership program at Concordia University, Irvine and to take our education to a higher level. As a retired professional engineer turned high school instructor, I felt that with God's help, I could do more to help our students, especially underrepresented minorities in the Science, Technology, Engineering, and Mathematics. My goal has always been to make a positive difference in the lives of my students. What an amazing journey it has been. I am blessed, and forever thankful for the encouragement and support I received from everyone around me during this amazing life chapter. Eternally grateful to my extended family from our amazing Cohort Irvine 6, especially my "brother" Paul Woo whose faith and perseverance inspired all of us. I also want to thank the faculty and staff at Concordia University School of Education, especially Dr. Doering and Dr. Kim for their unwavering support and help over the last few years. To my amazing dissertation committee chair Dr. Kim, and the very supportive committee members; Dr. Swamidass, and Dr. Kenney, thank you for all your guidance, and expert advice; as you helped me navigate this journey. To my friend and amazing editor, Dr. Seetal for all her help and patience, thank you. Lastly, I would like to thank my wonderful family for trusting and encouraging me with this endeavor and for sticking with me every step of the way, especially my loving, beautiful and patient wife, Laree who gave me the much needed life balance to pursue my dream of making a difference in the lives of underrepresented minorities.

CHAPTER 1: INTRODUCTION

This chapter presents the purpose, goals, and theoretical framework guiding the current study. The researcher also discusses the anticipated impacts of the study in addressing issues such as the STEM employment crisis by motivating students, particularly from Underrepresented Minority (URM) populations, to pursue hard-to-fill STEM careers. Based on a literature review and the researcher's experience as a teacher in STEM, hypotheses are also proposed.

History and Background

According to many economic experts (D'Alessio, 2014; Xue, 2013), and published data from the U.S. Bureau of Labor Statistics (Fayer, Lacey, & Watson, 2017), the United States (U.S.) will be facing an economic crisis in the near future that could have a widespread, detrimental impact on people's quality of life. Several sources have predicted that the U.S. will be experiencing a shortage of qualified employees in Science, Technology, Engineering, and Mathematics (STEM) areas (Hampton, 2013; Doerschuk et al., 2016). This shortage will likely result from the combined effects of the rapid growth projected to happen in the number of STEM jobs available in the next few years, and the difficulty experienced by employers in finding and hiring qualified employees to fill them. The number of students entering STEM careers and obtaining the qualifications required by new and increasingly complex emerging technologies will not be enough to satisfy the demand, forcing employers to look for skilled manpower from other countries, or lowering the standards expected of potential candidates. The shortage in STEM professionals is projected to lead to a nationwide lack of or drop in productivity, and an overall adverse effect on production and efficiency.

Another factor that exacerbates these concerns is the increasing dependency on foreign labor caused by the lack of local talent and its effect on the country's economy.

Many highly-paid STEM jobs are now occupied by foreign or foreign-born workers in the U.S. Some argue that these foreign nationals not only drive down STEM salaries but also take away jobs from Americans (Hossain & Robinson, 2012). Hiring foreign nationals at lower wages to take on the jobs that our graduates could not perform would represent a short-term solution to a growing problem (Collier, 2007). However, in the long run, those temporary employees may go back to their countries to help their national economies, leaving our workforce with an even wider employment gap. This dependency on foreign nationals threatens the global standing of the country as a world leader in STEM fields and research, since "it hinders the U.S. ability to sustain its competitive position" (Hossain & Robinson, 2012, p. 444). These foreign nationals may return to their country and compete with the U.S. for the lion share of the world's technology market.

This potential crisis is even more frightening, from a social and demographic perspective, as it not only adversely impacts the number of Americans filling those desirable and highly-paid STEM jobs, but it also threatens to widen the opportunity gap between the "haves," the economically-advantaged, and the "have-nots," the economically-disadvantaged, in society. There has been a disproportionate drop of underrepresented minorities entering and staying in STEM fields (Hurtado, Newman, Tran, & Chang, 2010). There is an even larger proportion of underrepresented minorities (URMs) failing to consider careers in those fields. According to Dr. Marshall Shepherd, from the University of Georgia, "minorities may be left out of the 21st-century job market if these trends are not reversed because most job outlooks continue to project STEM occupations to be the hot jobs" (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011, p. 24). Why do many minorities avoid STEM?

Another compounding factor augmenting the potential employment crisis is the growing minority population, which is projected to become the new majority in the near future. While in 1997, "white males" represented approximately 70% of the overall workforce; they are anticipated, based on demographic projections, to represent only 26% of that same workforce by the year 2050 (National Academy of Sciences et al., 2011). Charles Lu, Director of Academic Advancement and Innovation at the University of Texas, Austin, explained that "the disproportional representation of certain minorities in science disciplines grows increasingly problematic as greater portions of the country become majority minority" (Jones, 2013, p. 2). There is a need for the STEM workforce to keep up with those changes in demographics. "Having people of color not getting into or getting pushed out of STEM fields is posing a big problem to the education system and, ultimately, to the nation. This disparity in STEM fields will also have adverse economic implications as we have to keep outsourcing more jobs" (Jones, 2013, p. 2). As the new majority is created due to a shifting demographic makeup, it is paramount that participation and decision-making in industries such as STEM fully represent the values and interests of the general population. If a "new majority" is left out of that process, and the final policy decisions are made by the "former majority/new minority," the level of representation would be skewed, lack equity and potentially lead to unintended negative consequences.

Several sources have emphasized the need to tap into the pool of potential STEM workers in the URM community. A paper published in 2001 by the American Association for the Advancement of Science, and the National Science Foundation pertinently reported that to ensure a STEM workforce, it is vital that the country understands how to inspire and grow the talent of all U.S. citizens in the area of STEM irrespective of ethnic background or disability (George, Neale, Van Horne, & Malcom, 2001). Along similar lines, a 2008 article in Education Week highlighted "if the United States is to remain competitive, we need to ensure that children from every ethnic and economic background are prepared for jobs and potential careers in the fields of science, technology, engineering, and mathematics" (Litow, 2008, p. 1). In 2005, Latinos accounted for only 2.4% of engineering degrees awarded. However, the Latino population will make up about 25% of the overall U.S. population by the year 2050 (Flores, 2017). This fast-growing population illustrates the achievement gap that the STEM workforce is facing; it should be a wake-up call to those that have the power and the resources to drive change. We need to create policies that effectively provide verifiable and attainable solutions to those issues (Litow, 2008).

A National Science Foundation study gave another example of the disparity between minorities and Whites, reporting that "the gap in educational attainment separating underrepresented minorities and Asians remains wide" (National Science Foundation, 2015, p. 23). In general, underrepresented minorities are less likely than Whites and Asians to graduate from high school, enroll in college, and earn a college degree. "Although Whites' share of science & Engineering degrees has declined over the past two decades, they continue to earn a majority of degrees in all broad S&E fields" (Shepherd, 2016, p. 1). The pace at which Underrepresented Minorities (URMs) are entering the STEM fields is still lagging far behind the rate at which Whites/Caucasians and Asians continue to fill the jobs in the STEM fields. With fast-growing minority populations and the resulting demographic shift, it is important that policies and programs are designed to address the potential cultural differences and impacts needed to include URMs into those programs.

Interestingly, if the potential of qualified candidates within the Underrepresented Minorities (URM) that have been ignored or left out were harnessed, many of the projected vacancies in STEM could be filled. In 2014, the total STEM workforce of 16.1 million workers comprised 11.9% of the total national workforce of 135.3 million workers. The URM's are projected to comprise 17% of the overall U.S. population by the year 2020; thus, we should expect that URMs are equitably represented in the STEM workforce at the same or similar rate (The National Academies of Sciences, The National Academy of Engineering &

The Institute of Medicine, 2017). Simple proportionality calculations lead to the conclusion that for the representation to grow from the existing 9% to 17%, the number of URMs in STEM should almost double by the year 2020. This desired goal would require an 8% growth in a population of 16.1 million workers or an equivalency of 1.3 million new STEM workers.

Besides addressing the labor shortage, STEM can also provide viable upward mobility and opportunities to those that choose to make it a career, especially underrepresented minorities. A diverse STEM workforce will also benefit the local, regional, and national economies. It is important to note that the buying power of minorities continues to increase, which makes them more influential in various areas. As an example, the Hispanic population in the U.S. accounted for "$1.3 trillion in economic contributions" in 2014. These facts cannot be ignored; recognizing the needs of those key customers can only improve our economic outlook (Center for Online Education, 2015). Minorities also increase the diversity of opinions, ideas, and points of view that can boost creativity and innovation.

The key to influencing those traditionally forgotten demographic segments of our society, or URMs, is to identify the motivators and barriers commonly associated with their decisions to pursue or abandon their goal of working in STEM fields. The identification and exploration of those key factors would provide policymakers with information needed to address these inequities more efficiently by shaping and formulating research-based programs and policies. These programs and policies should become a unified and centralized effort that could easily be measured and calibrated to ensure the quantification of outcomes and attainment of goals. Many of these programs have been enacted at various governmental levels. A sizable amount of private investments also flows in support of these types of programs. However, implementers and policymakers have failed to track the successes properly or have had only marginal success in their endeavors.

Problem Statement

Many developed countries, like the United States, that have for years led the world in technological and scientific innovation and have growing and prosperous economies thanks to those highly technical industries, suddenly find themselves facing a potential economic crisis. Accelerated changes happening in the workplace, particularly the introduction of rapidly changing technologies, are causing skill requirements to shift quickly, giving rise to new jobs. However, industry experts, government agencies, and scholars project a significant lack of qualified workers needed to fill the rapidly evolving jobs of the future. The overwhelming growth in the number of jobs created in the next decade and the number and low-caliber of graduates currently delivered has kindled fear that those critical jobs would be difficult to fill (Olson, Riordan, & Executive Office of the President, 2012).

One of the industries which were hit the hardest by the employee shortages was the scientific community that includes Science, Technology, Engineering and Mathematics (STEM) fields and careers (Herman 2018). With the rapid evolution of technology, and the need for a lot of jobs to include some type of technical or scientific training, it is not surprising that the U.S. STEM workforce has grown at a rate four times that of total employment over the last twenty years (Graf, Fry, & Funk, 2018). It is estimated by the US Bureau of Labor Statistics that by the year 2024, there will be over one million new jobs in the area of Science, Technology, Engineering and Mathematics (STEM) that can potentially go unfilled due to the projected lack of qualified workers entering the employment pipeline (Fayer et al., 2017). The proportional number of Americans qualified to fill the jobs of the future have not grown (Hossain & Robinson, 2012).

Furthermore, the attrition rate in STEM fields is significant. A 2012 U.S. President's Council of Advisors on Science and Technology report estimates that the nation needs to generate one million additional college graduates in STEM by the year 2022. However, only

40% of the students who join college as STEM majors complete their degrees in STEM. This success rate is much lower for students that are first-generation students or are from a low socio-economic background (Doerschuk et al., 2016). If only 40% of students pursuing STEM degrees manage to complete their programs, it is unlikely that we would be able to fill all those new jobs without tapping into a new source of students with STEM aspirations.

Over the last few years, the United States' economic prowess, often attributed to a highly trained and educated workforce, has fallen in jeopardy, as its global ranking and standing continue to be eroded by the economic success of various emerging developing nations. Presently, the U.S. STEM industry, and more broadly, the U.S. economy are largely dependent on temporary foreign-born workers for making up employee shortages in STEM. Many of the highly paid STEM jobs are taken by foreign workers, jeopardizing the country's ability to maintain its global technological lead and success. The less dependency our nation has on skilled foreign labor, the more control it has in leading its economic efficiency, productivity, and workforce creativity. "The success, security and leadership position of a nation depend not only on the use of technology, but also on the number of native workers in STEM fields" (Hossain & Robinson, 2012, p. 442). Although some of the vacancies in technically-skilled STEM positions are currently being filled by guest workers working under H-1B visas, it is expected that soon that alternative will diminish, as other countries begin to challenge our traditionally strong economic superiority (Spillane & Jennings, 1997). The expected attrition in foreign labor provides additional justification to hire locally to maintain the country's global competitive edge.

There is also evidence that students are not pursuing STEM careers. The ongoing decline in the numbers and the quality of students pursuing those careers is cause for concern. Some of the reasons are the degree of difficulty, ignorance, and social stigma, amongst others. The nation should become more responsive to the needs of our economy-fueling industries by shaping students into more productive, efficient, and innovative future employees. This goal can be achieved in two primary ways. First, people surrounding students such as parents, family, friends, media, and even communities need to emphasize the importance of STEM to guide them into those careers. Many students are growing up in environments without guidance or adequate positive role models that they could imitate or follow. STEM needs to exist around them for them to aspire to be a part of it. Second, the educational system, for example, the ways that students are motivated and encouraged into various careers, should improve.

The National Center on Education and the Economy (2006) proposed a very valid solution to the lack of STEM competence: “The core problem in U.S. STEM education and training systems is that they were built for another era, in which most workers needed only a rudimentary education” (p. 8) Their report emphasized the need to revamp our education system to keep up with rapidly moving technologies and train the STEM workers of the future properly. With those thoughts in mind, we not only need to consider how to motivate our new generation of students better but we also need to figure out how to teach them (Hossain & Robinson, 2012). The quality and relevance of our pedagogical approach to STEM have come into question. Many have advocated for a fresh approach that departs from the traditional methods and emphasizes Project Based Learning, which calls for more hands-on strategies. Motivating our new generation into STEM careers requires understanding them and adjusting pedagogical practices to fit their learning style and needs so that they are influenced by the message. We need to deliver the message, and the message needs to be received.

The National Academy of Sciences, along with various members, from industry, academia, and the government authored a report entitled *Rising above the gathering storm: Energizing and employing America for a brighter economic future* (National Academy of

Sciences et al., 2007). In this report, several recommendations were made to avoid the potential economic crisis created by the shortage of STEM workers, and to respond to several questions by a group of Senators and Members of Congress on how to deal with the rapidly evolving economy (National Academy of Sciences et al., 2007). A follow-up report was requested five years later to assess the effectiveness of the earlier proposal and recommendations. In that report, they reassessed the original issue of how the United States should maintain its competitive position in the face of "rapid and deep changes in the global economy, investment patterns, advancing science and technology, and the global redistribution of skilled workforces, education, and innovation-driven industries" (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2010, Foreword). These reports not only outlined the potential employment and economic crisis ahead but also highlighted the lack of opportunities for URMs in STEM.

Although we appear to lack skilled workers, there is evidence that we have several segments of our society that are qualified but well-underrepresented in the STEM industries (Wong, 2016). Figures from the 2010 Census Bureau report that women make up about 52% of the U.S. population, while African Americans comprise 12%, Latinos make up 16%, and Asians 5%, with all other groups adding up to about 3%. Given those ratios, we would expect the STEM workforce to have similar demographic makeup; however, those actual numbers are not even close. African Americans represent 3% of the engineers, while Latinos make up only 4%, with Asians being the only overrepresented minority group at 11.6% (Fouad & Santana, 2017).

Given the vast amount of URMs that have been traditionally left out of STEM, it is possible that the answer to the STEM problem lies in getting those marginalized individuals motivated to seek STEM careers. Our failure to reach an ethnically balanced workforce and achieve equitable diversity goals has been attributed to "the failure of the academic pipeline to maintain a steady flow of underrepresented minority students." (Estrada et al., 2016). The solution, or at least part of it, lies in correcting that demographic imbalance and getting more Underrepresented Minorities to fill newly created STEM jobs. It is up to us to find better and more effective ways to reach and influence the traditionally ignored, yet valuable segments of our diverse society. If the potential of those demographic segments is not harnessed, there will continue to be a drastic imbalance in diversity and ethnic representation in the STEM workforce. The majority of future jobs are projected to occur in the STEM fields; thus, this imbalance is likely to translate into a disproportionate increase in unemployed or underemployed underrepresented minorities. In addition, underrepresentation could also lead to poor business decisions that would fail to consider the needs and priorities of an important, rapidly growing, and influential market segment. By attracting more URMs into STEM, the STEM industry could benefit from a more diverse set of perspectives and ideas that could, in turn, address the consumer needs of a culturally and ethnically diverse society, which is likely to be profitable for businesses.

The shortage of STEM workers in the United States is a cause for concern. However, a possible solution, as discussed, is to tap into URMs by motivating them to pursue STEM careers. Individual career choices can have several potential economic consequences on any given society; it is thus important for these choices to be aligned with the needs of the industries and businesses that fuel those communities. Although the possible economic benefits of alignment are more evident, there are also many social dividends that can result. Good career choices can produce happier and more productive workers that would create more successful businesses. This could yield healthier and wealthier local, regional and national economies. In summary, influencing students, particularly from URMs, to pursue careers that industries need can impact our country directly and positively, raising our national global economic standing. At the same time, this strategy could enhance the quality of life, and social wellbeing of Americans.

Efforts in the form of funding and ideas have been made over the last few years to increase the number of candidates pursuing and entering STEM careers, however, there are still lots of wasted energy, money and resources, as well as duplicated and fragmented attempts. Most efforts appear to have fallen short as the projected crisis still looms on the horizon. There is an obvious need for a unified and collaborative effort to create the desired impact on the STEM workforce effectively (United States Government Accountability Office, 2012).

The key question is: how do we motivate students from URMs to embrace STEM careers? There are many theories, variables, and factors that have been identified and associated with human decision-making. In particular, there are many studies focused on the way decisions about career choices are made. This body of research is discussed more extensively in Chapter 2. The degree of difficulty in making career decisions was partially summarized in a 1977 study for the Office of Naval Research entitled *Expectancy theory, decision theory and occupational preference and choice* (Mitchell & Beach, 1977); the importance of a career decision and the perceived irreversibility of the decision were correlated. The study reported that, once a person chooses a career, and invests time and resources into it, it becomes very difficult to go back. Although that attitude may have softened or changed slightly since the 1970s, the level of personal and often financial commitment that is required still makes career decisions very difficult to take (Mitchell & Beach, 1977).

Change often seems to be the answer to many of our problems. However, according to Kurt Lewin's theory of change, "group, organization, or social system change does not occur by simply shifting individual behavior but requires the larger system to shift as well" (Burnes & Lewin, 2004, p. 983). This implies that a shift in the demographical makeup of the STEM workforce towards more diversity and inclusivity would require a collective effort and a systemic change. Our aim needs to be broad and general; we should not only target individual attitudes and behaviors but also aim to adapt the policies and protocols that affect those attitudes and behaviors (Estrada et al., 2016). The change needs to take place at the organizational, as well as the individual levels. The goals should be embraced by all the stakeholders, from the broader federal, state, and local governments, down to the communities, schools, families, and ultimately, the targeted students. There should also be a uniform set of policies and programs that would align with these goals. Firstly, these programs should focus on preparing students to make smart career choices whether or not students have had exposure to particular careers. Secondly, they should promote understanding of STEM careers, and emphasize their benefits. Thirdly and most importantly, they should give confidence to students about their ability to succeed in STEM careers. It would be beneficial for some programs to target parents, family members, teachers, and others who form part of the students' overall social network of support, so they acquire, at least, a basic understanding of STEM. This would equip them with the know-how to influence students, especially URMs, to become STEM practitioners.

Purpose of the Study

There have been many unproductive discussions, policy changes, research studies, programs, proposals, as well as an array of fragmented and expensive efforts invested in addressing the STEM employee shortage. There is a need to use research evidence to find an impactful solution that is also easy to understand and execute. This need has shaped the intent of the current study.

The main purpose is to identify actual and actionable motivating factors, along with the people and the actions behind them, which influenced the decision of STEM practitioners to pursue and enter their particular fields. The research thus primarily focuses on, using these factors, to make recommendations about how to motivate underrepresented minorities to pursue and achieve in STEM or STEM-related careers. Those motivating factors could potentially inform policymaking and the creation of programs that could be implemented across communities and educational levels. The influence needs to be comprehensive; it should start at home and school, be reinforced by the media and extend to the community while including active governmental support in engaging all stakeholders such as industry and academia.

A secondary purpose of this study is to examine whether there would be a crisis due to a shortage of qualified STEM candidates, and if so, better quantify that shortage and how it relates to the untapped pool of URMs with the potential to fill those jobs. The author administered survey instruments and interviewed a statistically representative sample of the population to identify strategies that could be used to motivate students, especially underrepresented minorities, into pursuing careers in those fields. The main idea was to target successful STEM practitioners who opted for those careers. Using a mixed method research design, the study aimed at identifying the motivational factors that influenced them into pursuing, entering, and persevering in those careers. This research, to a lesser degree, also aimed to investigate and identify the barriers that these professionals faced and overcame in their quest to pursue a STEM career.

Research Problem

A question worth considering is: What motivating factors have influenced successful STEM professionals, especially URMs, to pursue a STEM career? There are many studies addressing factors influencing students' decisions to enroll in STEM programs and pursue STEM careers. However, there is a gap in the research on motivating factors in STEM, which uses the expectancy-value theory of motivation (EVT) and the social cognitive theory (SCT) as theoretical frameworks. There is also limited research on how these factors apply to the very diverse and unique career categories within STEM. The current study sought to address these gaps by exploring potential connections between EVT and the SCT elements, and the factors that motivated STEM professionals to get into their specific fields or careers. Particular emphasis was placed on the factors that influenced the decisions of URM students and STEM practitioners.

The study identified the various and distinct motivators that influenced students from various demographic subgroups (gender, ethnicity, age, socio-economic status, etc.) to enter and pursue STEM careers. The sample population not only represented the STEM fields and its sub-professions, but also the various levels of experience and responsibility within each of the professions. Much effort was put into recruiting a significant subsample of traditionally underrepresented groups, so the unique motivational factors that affect them are correctly identified and documented. Their representation was paramount given that underrepresented groups are rapidly growing in the overall population ratios, and level of societal influence while continuing to be drastically underrepresented in the STEM workforce.

Research Questions

By influencing minorities into STEM fields, we could decrease the dependency on foreign STEM workers, fix the leak in the STEM pipeline, and simultaneously bridge the opportunity gap that has kept so many URMs away from STEM careers. These actions would allow the country to establish a more efficient and productive STEM workforce, less susceptible to the demands and threats of global competitors, while at the same time bringing equity and cultural diversity to the STEM workforce. The study attempts to answer several critical questions to identify the root causes of the declining participation of students, particularly URMs, in STEM activities and careers. This research focuses on the factors that have traditionally motivated successful STEM practitioners to pursue and remain in the field. It also sought to identify specific motivators and barriers that affected the career decision of traditionally underrepresented minorities, since their equitable participation could supply the qualified workers that the STEM industry needs. The research questions focus on identifying and validating the motivational factors that have been raised by other researchers as a potential influence in career decisions by STEM professionals, especially those classified as URMs.

The primary research question guiding this study was:

1. What are some of the strategies needed to encourage, motivate, and support underrepresented minorities (URM) into STEM careers?

The researcher used three secondary exploratory questions to ascertain a valid array of answers:

2. For successful STEM practitioners, what enabled them to pursue STEM careers?
3. For successful STEM practitioners, what are the barriers they faced and overcame while pursuing STEM careers?
4. How are these barriers and motivators different for successful URM and non-URM STEM practitioners?

While performing the literature review, the researcher also covered other related topics that could have relevance or bear on the issues of the STEM employment crisis and the underrepresentation of minorities in the STEM workforce. Some of the topics are covered in the next sections.

Theoretical Framework

There are certain factors that motivate individuals to pursue careers in STEM fields. A key question is: Are there patterns or relationships that connect these motivators? There are several theories that focus on career decisions and the many factors that influence them. Some of these theories include the social cognitive career theory (SCCT), expectancy-value theory (EVT), goal orientation theory, and the intrinsic/extrinsic motivation theory. The researcher chose two major theories that focus on the rationalization of the decision-making process, the expectancy-value theory of motivation, and the social cognitive theory as guiding frameworks for this study. They allowed the researcher to explore the potential motivators behind students' decision to choose and pursue STEM careers.

Since the topic of interest and the problem of practice for this study was the motivation of students into STEM careers, the research primarily drew from similar work. Although human decisions are constantly made, some are relatively inconsequential, while others can have lasting impacts on the lives of individuals. One of those decisions involves choosing a career, a line of work, or a profession that would bring enjoyment and offer the possibility to make a comfortable living. The factors and influences that lead to those decisions are usually many and often vary depending on the setting, environment, peer/family support, and the experiences that have shaped the personality of an individual. A few studies have similarly used theories such as the social cognitive career theory, expectancy-value theory, goal orientation theory, and intrinsic/extrinsic motivation theory as guiding frameworks to suggest potential explanations about what motivates students into STEM careers (Martin & McAlear, 2016).

One of the first articles that this study drew from was motivational beliefs, values, and goals by Jacquelynne Eccles and Allan Wigfield (2002). In that article, the authors reviewed recent studies and summarized findings on motivation, beliefs, values, and goals, while focusing on developmental and educational psychology (Eccles & Wigfield, 2002). They explored four basic categories of theories that focused on expectancy for success, task value, expectancy/values, or motivation/cognition. Although there were several theories addressed by this research study, two of those theories addressed the immediate issue at hand, which was the identification of the reasons and motivators that have influenced STEM practitioners to pursue their careers. Those theories were the expectancy-value theory of motivation (EVT), and the social cognitive theory of motivation (EVT), both of which looked at perceived self-efficacy as a primary driver of career decision-making. Self-efficacy was defined by Bandura as: “people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (Bandura, 1994, p. 2). People tend to take risks when they feel that they have mastery over a subject. The connection between a sense of mastery and risk-taking seems simple; however, there are many diverse and complex factors that influence that sense of mastery, which, in turn, depend on environmental and social elements.

The researcher reviewed a vast number of articles and publications to identify a gap in the research, formulate a concise and clear problem of practice, and identify a comprehensive list of variables that were adequate for use in the identification of the motivating factors that typically influence students to choose the STEM career route. Using a dual theoretical framework allowed the author to identify the relevant variables and formulate the research questions that effectively yielded the data needed to answer the central question of the research. The chosen theories accurately and effectively reflected and addressed the motivational factors associated with students’ career selection. The hypothesis that was formulated was that the decision to pursue any given career, in this case a STEM career, is highly influenced by the upbringing and environmental setting (social cognition and sense of self-efficacy) that the individual has been exposed to, as well as the expectations, values and risks (subjective task value and cost) that he/she expects as outcomes from the decision.

Expectancy-Value Theory of Motivation

According to Wigfield and Eccles (2000), who studied career decisions, and the principles behind the expectancy-value theory, there is a direct relationship between career decisions and the factors that influence individuals to choose those careers. In 1983, Eccles defined the ability beliefs of individuals as “broad beliefs about competence in a given domain, in contrast to one’s expectancies of success on a specific upcoming task.” (Eccles &

Wigfield, 2002, p. 119). The value of that task as compared to the confidence in the ability to be successful plays a major role in the decision of whether the task is taken. Eccles (1983) further defined the task-value as: attainment value (personal importance of doing well on the task), intrinsic value (enjoyment the individual gets from performing the activity), utility value (how does the task relate to current or future goals), and cost (conceptualized in terms of the negative aspects of engaging in the task) (Eccles & Wigfield, 2002).

The expectancy-value theory of motivation integrates expectancy beliefs with subjective task values, which are derived from attainment value, intrinsic value, utility value, and cost (Wigfield & Eccles, 2000). This theory attempts to balance the value expected from a decision against the cost and effort of performing the task. In 1983, Eccles developed an expectancy-value model "of achievement choice as a framework for understanding early adolescents' and adolescents' performance and choice in the mathematics achievement domain." In that model, several constructs were considered, ranging from achievement behaviors of the children (performance and choice) to their beliefs and values (subjective task values, expectancies for success, achievement goals, and ability beliefs). Some of these variables were included in this research as part of the research questions and were incorporated, in more detail, into the research instrument.

In making career choices, students often weigh what they perceive or expect as potential attainment (salary, social status, etc.) if they pursue a field of study against the amount of effort or cost it would involve (work, training cost, marginalization, time, social status, etc.). This study aimed at identifying the factors that outweighed the cost, thus motivating STEM professionals to find the value in pursuing their careers. The expectancy-value theory of motivation addresses attitude-related variables that affect behavior, intent, and goals. The researcher formulated the research questions around several of these variables, such as ability beliefs, expectancies for success, and task values (Chauncey, n.d.).

Key questions that often help individuals in their decision to pursue a STEM career include: “Am I cunning enough? Am I genuinely interested? Do I enjoy working with mathematics tasks? Is science “me”- can I comfortably identify as a science student? Will this course of study lead to a thrilling career and high income? How much time and effort will it require?” (Bøe & Henriksen, 2011). The EVT addresses all of these important questions. This theory has often been used as a tool to assess students’ academic achievement and choices, including the personal efforts and sacrifices they entailed. According to a recent study, competence and value beliefs exemplify the most proximal forerunner to educational performance, effort, and engagement (Guo et al., 2016). Competence beliefs are very closely associated with self-efficacy and self-confidence, which are better addressed under the SCT. The individual value beliefs of intrinsic, attainment, utility, and cost, are better defined and addressed under the EVT. However, the cost element under the EVT lacks empirical depth of analysis; there have been several studies that have attempted to rectify, supplement, or complement that oversight. That component of EVT has been defined as the amount of talent a student needs to sacrifice to get involved in that task (Flake, Barron, Hulleman, McCoach, & Welsh, 2015). Cost, however, can take many subjective shapes, as it is defined as what the student is “giving up” as a consequence of his decision or as an attempt to achieve his goal. These costs can range from the perceived loss of social status due to marginalization or ostracization by peers to the perceived loss of an opportunity for having done something else which could have possibly brought a better outcome.

Another component of the EVT that has been closely linked to student decision-making is expectancy. Expectancy is highly dependent on exposure and knowledge about what could be achieved. As brilliantly stated by Beatriz Ceja, from the US Department of Education during the researcher’s Concordia University cohort trip to D.C., “People cannot aspire to be something that he/she has never seen." This philosophy has been supported by a longitudinal study entitled, will I succeed in Engineering? In this study, the authors stressed that learners should be exposed to an array of engineering career prospects so they can develop precise perceptions of the work of engineers, the skills required and their abilities (Matusovich, Streveler, Loshbaugh, Miller, & Olds, 2008). These important pieces of knowledge are a byproduct of the environment and the people that the students are exposed to, and thus can be explained using the SCT. However, it is important to address them from both theoretical perspectives. One particular area of influence addressed by Eccles is that of parental input in shaping children's perceptions and expectations of their ability to succeed in various fields, may it be in sports, academics, or any other endeavor. The theory connects "parental socialization practices with children's motivational characteristics" (Horn, 2008, p. 272). Parents have a profound impact on their children's values, education, beliefs, and attitudes; they play a significant role in development of their children's motivation. Students' interest and perception of the utility or usefulness of any given task determines whether he decides to take it or not; career choice is one of those critical decisions (Lazarides, Harackiewicz, Canning, & Pesu, 2015).

The expectancy value theory has served as the foundation for the formation of a parallel theory, which includes racism-related constructs. In this new theory, students' motivational experiences were studied under a concept called the racial opportunity cost (ROC). This study from the Michigan State University is premised on the assumption that when EVT was produced, there were some aspects such as the social and cultural elements which were not considered; thus the harassments, opinions, and needs of underrepresented students of color were not theoretically embedded within the theory(Chambers, 2015). This assumption deserves some credence since, for URM students, the variables of "expectancy" and "value" could take a very different dimension than those assumed for non-URMs. Given the negative experiences and barriers often faced by URM students, one can easily presume that their conception of task values may be different. The cost beliefs, perceived utility, and the attainment values, as well as the expected intrinsic values driving the decision of a URM student, need to be considered as we analyze the factors that influence those decisions (Seals, 2016).

The EVT has been used in some studies focusing on STEM fields. A study entitled the emotional cost of computers: an expectancy-value theory analysis of predominantly low-socioeconomic status minority students' STEM attitudes was conducted in 2017 to explore the reasons for which females and minority students were underrepresented in STEM fields. The specific intent was to explore the factors that incite or dissuade students from pursuing a STEM career. The study found that positive expectancies for success and subjective task value are good predictors of students' positive attitudes towards STEM. Emotional costs towards technology, however, predicted negative STEM attitudes. These findings led to the conclusion that under the EVT, there may be a "push-and-pull" effect on the formation of STEM attitudes for URM students (Ball, Huang, Rikard, & Cotten, 2017). Although the study focused on elementary school students, the findings were generalizable to larger and more diverse populations.

The expectancy-value theory was also used as the theoretical framework in another study used to assess and compare the persistence of 9th-grade high-ability students of various ethnic groups in STEM. This study by the National Science Foundation (2008) revealed that Blacks and Hispanics were underrepresented by more than 50% in undergraduate engineering programs when compared to their proportion in the general population, while Whites were overrepresented by more than 10% (National Science Foundation, 2017). The author highlighted that as population diversity grows in the U.S, it is important to carry out further research that could facilitate the academic persistence of talented URMs who may otherwise be left out of the STEM workforce. It is important to nurture and build self-efficacy in all students while targeting extra efforts towards those who face greater adversity (Andersen & Ward, 2014).

Social Cognitive Theory (SCT)

This theory has been defined as the integration of behavior, as well as the environmental and personal factors, into the learning and decision-making processes. It explains the relationship between environment and behavior. This theory is based on the assumption that people learn by observing others and that their conduct is eventually shaped by the behavior that was observed. The SCT primarily places emphasis on social influence and internal/external social reinforcements. Behavior is acquired and driven by the environment in which it takes place while being influenced by past experiences.

According to Bandura (1993), in social cognitive theory, people are neither driven by inner forces nor automatically shaped and controlled by the environment. They function as contributors to their motivation, behavior, and development within a network of reciprocally interacting influences. People are characterized, through this theoretical lens, in terms of a number of foundational capabilities (Bandura, 1993). Those capabilities are: symbolizing, vicarious, forethought, self- regulatory, and self-reflective (Bandura, 1986, 1989, 2002). In his work, Bandura explains the model of causation as the principal foundation of the SCT. As he addresses the various developmental changes that people go through over time, he emphasizes the importance of the social setting and environment, and the impact they have on the changes and decisions that come with them. He goes further to say that diversity in social practices yields considerable variances in the competences that are nurtured and those that continue to be underdeveloped (Bandura, 1989).

A relatively new theory, founded on Bandura's work on SCT, has a more focused approach to the decision-making process associated with career selection. This theory, the social cognitive career choice theory (SCCT), "focuses on several cognitive-person variables (i.e. self-efficacy, outcome expectations, and goals), and how these variables interact with other aspects of the person and his or her environment (i.e., gender, ethnicity, social supports, and barriers) to help shape the course of career development" (Lent, Brown, & Hackett, 2000, p. 1). This theoretical model addresses a very important element, the environment, and the influence of those around our students that appear to be played down in the EVT.

"People have the power to influence their own actions to produce certain results. The capacity to exercise control over one's thought processes, motivation affect and action operates through mechanisms of personal agency" (Bandura, 1999, p. 3). Those personal dynamics are key to decision-making; they have a major influence on career choices, on how people arrive at the point of deciding what they want to do for a long time (day in and day out) and on their willingness to invest the time and resources to get there. Those decisions are a byproduct of the social environment, as well as the vigorous interaction between personal and situational influences (Bandura, 1999). The influence of the family, teachers, and coaches, as well as the examples set by social, cultural, and celebrity role models, are of primary importance in shaping the attitudes and opinions developed by the next generation of workers. Those social cognitive factors are thus key to influencing the careers they choose to pursue.

Scholarly literature has supported Bandura's (1993) views on the impact of social factors on the skill development of students. A study was conducted by the Level Playing Field Institute to examine students' perceived barriers, STEM aspirations by gender and race, as well as the coping mechanisms they used (Scott & Martin, 2014). Some of the structural barriers to educational access and opportunities encountered by URM students included stress, coping, and stigmatization. The authors realized that, given the rapidly shifting demographics in the U.S., the high degree of underrepresentation of certain minorities, and the growing demand for skilled STEM workers, it was important to find new ways to motivate minority students to join high-demand STEM fields (Scott & Martin, 2014). One of their findings was that African American and Latino high school students experienced widespread racial bias and discrimination. Those same students also perceived racism to be commonplace in institutional and societal contexts. This research provides support for the social cognitive career theory, which explains that self-efficacy is influenced by the experiences that are shaped by the gender and race of the students. Those perceived barriers greatly impact the students' career decision-making (Scott & Martin, 2014). The way those perceived barriers are removed and dismantled will have a considerable impact on the decisions of URMs to pursue employment and careers in STEM fields.

The researcher of the current study was primarily interested in exploring the various types of factors that motivate, incentivize or, influence the decision of STEM practitioners to pursue their particular careers. The goal was to formulate the research questions around the main constructs behind the expectancy-value theory (expected task, value, and cost) and the social cognitive theory (social and environmental influences), which are both driven by the same central theme: perceived self-efficacy. Self-efficacy, addressed by Bandura as a central piece of his social cognitive theory, is defined as the characteristic of "people with high assurance in their capabilities, approach difficult tasks as challenges to be mastered rather than as threats to be avoided" (Bandura, 1994, p. 2). There are four primary sources from which self-efficacy is drawn. They are mastery experiences (prior successes), vicarious experiences (observations and role models), verbal persuasion (parents, teachers, and coaches), and emotional and physiological states (depression, and positive or negative emotions) (Akhtar, 2008).

The survey questions used in this study also integrated Bandura's idea that perceived self-efficacy "exerts its influence through four major processes (Schunk, 2000, p. 1). They include cognitive, motivational, affective and selection processes" (Bandura, 1993, p. 1). The perceived level of self-efficacy associated with a chosen STEM field at the time of career selection, coupled with considerations of the motivating factors of expected value, cost, and environment put forward by the EVT and SCT, provided some explanations as to what works. Examination of the positive motivators, and how they vary by demographic factors, would provide research evidence for crafting appropriate policies and actionable programs that could be implemented nationwide. We can thus influence the volume and diversity of graduates entering the STEM workforce.

In the current study, the researcher integrated the elements of both the SCT and SCCT into the variables used in this study, such as self-efficacy and motivation. This allowed the researcher to identify who and what are behind the factors that influenced students to pursue a STEM career better. Constructs in the field of motivation are "beset with a lack of clear definitions" (Schunk, 2000, p. 1). The researcher thus took care of defining the variables related to motivation and specifying their operation within the framework. Self-efficacy was primarily measured through an analysis of the state of mind of the participants when they made the decision to pursue a STEM career. Valuable information about self-efficacy was also collected by asking participants who influenced them in their career decision, who their role models were, or who the people in STEM they hoped to emulate were.

Significance of the Study

This study identified motivating factors and strategies that are easy to understand and implement; they could be used to encourage and influence students from all walks of life, regardless of race, gender, or socioeconomic status, into pursuing careers in the STEM fields successfully. However, a collaborative effort between students, parents, educators, and community and industry leaders is necessary to support the implementation of these strategies. Successful implementation could shape our educational system to respond to the needs of the STEM industry more effectively. Improvements are necessary for students' instruction, and social awareness about STEM. The individual and global motivational strategies used to motivate students into these fields should also be revised. We could thus not only increase the number and ethnic diversity of students entering the STEM fields, but also raise their skill levels to match those demanded by the industry.

The number of students starting with the intention of becoming a STEM practitioner is robust. However, there appears to be a high rate of attrition at the high school and college levels, when many students opt for a different career path. This could be explained using the STEM pipeline metaphor. The STEM pipeline metaphor describes the inflow of students into the STEM educational system from early on, all the way through primary, secondary, and post-secondary school levels. This metaphor portrays the number of students at any given junction of the educational system, including the "leaks," the students that drop out from pursuing STEM careers. It is important to feed the "STEM pipeline" from the start (primary grades) and continue to monitor it along the way (middle and high school) to avoid leaks. This would increase the number of students interested in STEM, but most importantly, create a healthy, diverse, and robust workforce that would help the United States avoid an economic crisis, and regain its global technological power.

There have been many efforts and programs aimed at increasing the number of students entering STEM careers, some aimed at encouraging and influencing the traditionally underrepresented groups such as women and minorities. These efforts, however, lacked congruency or were disjointed or fragmented. There are large disproportionate STEM pipeline leaks for URMs; the percentage of URMs dropping out exceeded the percentage of non-URMs doing the same. This study was intended to explore and identify the main factors that influenced students into pursuing specific career fields, especially STEM, and provide a unified platform upon which remedial efforts could be built.

The main purpose of this study was to examine the factors that influence students to enter and succeed in STEM fields. In doing so, the research provided policymakers and educators with the tools needed to create comprehensive programs founded on a single theoretical framework that combined effective motivators and the interplay between them. These new programs and policies should be tailor-made for various audiences, including parents, teachers, and community members, amongst others, so they are equipped to motivate our new generation of students into pursuing STEM careers. By increasing the number of students, graduates, and qualified workers in STEM, the country can position itself in a very favorable economic standing within global markets. Furthermore, as we are able to organically fill the thousands of jobs created annually by our growing number of STEM employers, we can also bridge the opportunity gap that has excluded and ostracized many qualified members of our URM community from STEM careers.

Assumptions

There are assumptions identified by the researcher that can impact the validity of this study. First, the researcher assumed that the STEM employment gap can be breached with qualified URMs, while at the same time providing much-needed diversity to the workforce and alleviating the social inequity that now exists. Second, the researcher assumed that the participants were familiar with basic key terms related to STEM fields.

Definition of Terms

STEM: Acronym for Science, Technology, Engineering, and Mathematics, which defines careers, professions, students, practitioners, professionals, and anyone or anything associated with those branches of education, research, and employment.

STEM Professional: Anyone working or practicing within any of the branches of STEM and utilizing the scientific concepts and principles taught under any of those scientific disciplines.

STEM Careers: Any job or profession at any level of proficiency associated with any of the branches of STEM. This includes sub-professional and entry-level jobs, tasked with a single task, and requiring minimal training as well as the more complex jobs requiring several years of training and the professional levels where licensure is required.

Scientist: Anyone working in scientific research or supporting scientific research at any level of employment, from a lab technician to the principal researcher.

Technologist: Anyone working in the design, manufacture, or implementation of scientific concepts at various levels, from field technician, entry-level laboratory aides, manufacturing tech, or draftsman/designer; to highly skilled manufacturing technicians and complex system operators.

Engineer: Anyone with an engineering degree working as an entry-level apprentice to an experienced licensed engineer managing projects, people, and resources. This category includes anyone that can legally use the title of "Engineer" and can include any of the four primary engineering fields of Civil Engineering, Electrical Engineering, Mechanical Engineering, and/or Chemical Engineering. This category can also include the various subcategories and derivative engineering careers, such as agricultural engineer, architectural engineer, aerospace engineer, aeronautical engineer, construction engineer, industrial engineer, materials Engineer, manufacturing engineer, nuclear engineer, etc.

Mathematician: Anyone with a degree in mathematics involved with the research, education, or scientific support of any other field or profession, from credentialed teachers to college professors; and from research assistants to theorists and principal researchers.

STEM Employment Crisis: According to data published by the US Bureau of Labor Statistics, and a report to President Obama entitled *Engage to Excel*, over the next decade, there will be a shortage of approximately 1 million STEM professionals. If the United States is to maintain its global standing in science and technology, the number of STEM graduates should be increased by about 34% over the current rate of graduations (Olson et al., 2012). This shortage of qualified STEM workers is projected to have an adverse impact on the U.S. economy that will not only affect our global economic standing but erode our current way of life and standards.

Expectancy Value Theory of Motivation (EVT): According to Wigfield and Eccles, (2002), there is a direct relationship between career decision and specific factors that influence individuals to choose those careers. In 1983, Eccles defined ability beliefs as wide beliefs about capability in a given area, in contrast to one's expectancies for success on a particular forthcoming task. The value of the task, in comparison to the confidence in the ability to be successful, plays a major role in the decision to accept the task. Eccles (1983) further defined the task-value as: Attainment value (personal importance of doing well on the task), intrinsic value (enjoyment the individual gets from performing the activity), utility value (how the task relates to current or future goals), and cost (conceptualized in terms of the negative aspects of engaging in the task).

Social Cognitive Theory (SCT): Primarily developed by Bandura (1994), and also associated with the social learning theory, this approach attempts to explain the relationship between environment and behavior, where observation of others can shape the personality and attitude of individuals. According to Bandura (1994), in social cognitive theory, people are not motivated by internal forces and are not automatically formed and controlled by the environment. As we have already seen, they function as contributors to their motivation, behavior, and development within a network of reciprocally interacting influences. People are characterized within this theoretical perspective in terms of a number of basic capabilities (Bandura, 2002, p. 4).

Social Cognitive Career Theory (SCCT): Relatively new theory developed by Lent, Brown, and Hacket in 1994 as a derivative of Bandura's social cognitive theory. The idea was to explore the three interrelated elements of career development; how academic/career interest develops, how educational/career choices are made, and how academic/career success is attained. The theory was founded on three primary variables: self-efficacy beliefs, outcome expectations, and goals.

Professional Organizations: There are many professional and social platforms representing and unifying the various trades, careers, and professions within the fields of STEM. They include STEM workers at various levels of the professional spectrum; from professional organizations like the American Society of Civil Engineers (ASCE) representing college students, practicing sub-professional civil engineers, licensed civil engineers and civil engineering educators and policymakers, to labor organizations and unions representing skilled labor in the areas of construction and laboratory technicians.

Underrepresented Minorities (URM): These ethnic groups are traditionally underrepresented in the STEM workforce. They consistently include African Americans, Latinos, Pacific Islanders, and Native Americans (including Alaska). There is an acute disproportion between the number of URMs composing the general U.S. population and the number of URMs employed in STEM careers. This disproportion in ethnic diversity has created an opportunity, success, and prosperity gap between the URMs and the rest of the U.S. population.

Limitations

Limitations are constraints that are normally not under the control of the researcher. However, by identifying potential factors that could influence the results, the researcher alleviated some of their impacts. An effort was made by the researcher to recruit a truly statistically representative sample of the STEM workforce population in the U.S. by contacting the organizations representing the major disciplines in the community and obtaining participation by its members. Hence, people from most categories of professions and levels of work provided their input.

Ethical and legal requirements set forth by the Institutional Review Board also set some limitations on the way information is solicited, particularly from traditionally underrepresented groups in STEM. Some of these groups may be considered vulnerable; their socioeconomic and cultural backgrounds may have created predispositions towards certain types of questions, and how they are worded. The researcher thus put in additional sensitivity and cares in devising the questions used in this study.

Delimitations

These are self-imposed boundaries that are set on the purpose and scope of the study (Lunenburg & Irby, 2008). The researcher has delimited the population sample to STEM professionals that have successfully overcome adversity to join and progress in their careers. The study concentrated on all categories and levels of STEM jobs; however, it only included a population that received the relevant scientific training or education.

Summary

This research project is founded on a real-life problem of practice in which the researcher, as a STEM instructor and professional, witnesses every day. The low numbers of students pursuing STEM fields, especially those from low-income families and minorities (including women) represent a major issue within the STEM industry in the U.S (Bidwell, 2015; National Academy of Sciences et al., 2007, 2010), and the Although the STEM employment crisis is very real, the causes and reasons for that crisis are less clear. Furthermore, there is a research gap in the area of implementable programs that would teach various audiences such as parents, educators, and community members about STEM, its benefits, and the factors that motivate people to embrace STEM careers.

This research aimed at examining career motivators among professionals who are already practicing in the STEM fields. Ultimately, the study aimed to provide options and explanations that could be used to design new programs and establish new policies for increasing the number of students entering and pursuing STEM careers. With more students entering those STEM fields, the country should be able to have enough qualified candidates to fill the projected STEM job growth, and ultimately avert a dreaded economic crisis.

There is justification for tapping into underrepresented minorities for addressing the STEM worker shortage. The preliminary literature review revealed that those Underrepresented Minorities (URMs) are: Blacks/African Americans, Hispanics/Latinos, Pacific Islanders, and Native Americans. The diversity imbalance in the STEM workforce has denied opportunities to URMs who could be shaped into qualified candidates and represent the solution to the STEM crisis, bringing the demographic equity and social fairness that is appropriate for our society and our economy.

The two theoretical frameworks chosen for this study, the expectancy-value theory and the social cognitive theory, offer very persuasive arguments in favor of identifying the "motivators" that influenced students to pursue STEM careers as a strategy for increasing the pool of potential STEM workers. Two main strategies were used in this study to identify key factors that could be effectively utilized in practice to influence more students into STEM fields. First, the individual constructs and variables that relate directly to those potential motivational factors were identified from the literature. Second, questions were created based on each of the constructs to gather pertinent measurable data from participants, such as the specific values important to them and the people that have been most influential in their lives. The questions posed in the questionnaire were also aimed at providing measurable data about the degree of influence exerted by each of the independent variables on the study's main dependent variable, the student's decision to pursue a STEM career.

Principles gleaned from the expectancy-value theory were also considered in devising questions. According to this theory, career decisions are typically influenced by perceived self-efficacy (how good am I at this), as well as the perceived value (what's in it for me). Often parents, peers, teachers, relatives are instrumental in boosting that self-efficacy in students. Values such as wealth, honesty, and recognition are also seen as factors that persuade or discourage students from pursuing a particular career. The questions were thus also tailored to explore the amount of influence of those variables.

Some of the limitations of this study include the presence of extraneous variables such as the adequate representation of participants from various STEM-related fields. However, efforts were made to recruit a heterogeneous sample, which would be more representative of the general population. Furthermore, the researcher adhered to IRB recommendations for dealing with vulnerable populations; much thought and consideration went into devising questions that were culturally sensitive. The researcher delimited the research mainly to STEM professionals within the United States, belonging to STEM professional organizations. While the current chapter covered the problem statement, purpose, research questions, significance, theoretical framework, limitations, and delimitations of the study, Chapter 2 will give a comprehensive review of the literature.

CHAPTER 2: REVIEW OF THE LITERATURE

In this chapter, the researcher described the approach that was taken to identify the topics and subjects relevant to the primary research question of this study which was: What are some of the strategies needed to encourage, motivate and support underrepresented minorities (URM) into STEM careers? In addressing this research question, the researcher identified the most effective and successful strategies which could inform the better allocation of resources to programs supporting STEM participation.

This includes the review of books, articles, studies, and other sources on three main topics: The STEM field and job crisis, underrepresented minorities in STEM, and career decision Motivators that affect the "STEM Pipeline." The STEM crisis section includes a brief history of the STEM worker shortage problem, the economic crisis that it may bring, and a possible solution to the problem which involves harnessing the potential of underrepresented minorities. This section is followed by a detailed discussion of the two motivational theories used as the theoretical framework for this study.

The researcher also covered a comprehensive list of potential motivation factors derived from the expectancy value theory and the social cognitive theory; and how they relate to career motivation and URMs in STEM. The researcher included literature about the motivators that work for the new generation of students, and that can shape new programs and policies aimed at attracting more students into STEM careers. Emphasis was placed on examining particular motivators associated with motivating URMs that may be different from those factors that influence Non-URM students. The researcher identified and defined the motivators that motivate both groups of students.

An unscientific ranking of motivational factors was created by assessing and counting the number of articles and publications that identified specific factors as the primary motivators, therefore yielding a list of those factors based on publication frequency. As an example, the parental influence factor appeared as the primary factor contributing to the students' decision to choose a STEM career in about 30% of the motivation articles reviewed, with teachers and school coming a close second at about 25% of the time.

What is STEM and why it is important?

STEM is an acronym coined by the U.S. National Science Foundation (NSF) in 2001, which stands for Science, Technology, Engineering, and Mathematics. It is commonly used to identify the fields, jobs, disciplines, professions, and careers that are associated with those areas of study, research, or work. There are multiple pathways that lead to STEM careers. Careers in STEM range from jobs requiring minimal training such as entry-level technician jobs to highly skilled professional careers that require years of professional training and licensure where months are required to perform a single specialized technical task. Other STEM practitioners include doctors, engineers, teachers, researchers, nurses, designers, and many other professions that require the use of scientific principles on a daily basis.

According to 2009 data from the U.S. Department of Commerce's Economic and Statistics Administration, and the Bureau of Economic Analysis from the U.S. Department of Commerce, STEM jobs should also include professional and technical support occupations in the fields of computer science and mathematics, engineering, and life and physical sciences, including the management occupations that are tied to STEM. Education and social science jobs are not included in this definition. The list of occupations is divided into four categories (computer and math, engineering, physical and life sciences, and managerial) and total 50 specific codes (Beede, Julian, & Khan, 2011).

History of the STEM Crisis

For several decades, starting with the technological advances following World War II, there has been a growing concern about the nation's ability to keep up with the recruitment needs of new industries and disciplines resulting from scientific innovations and discoveries.

Potential employers have raised valid concerns, based on existing trends, about the quantity and quality of graduates being generated by the country's educational institutions. They project that this situation would affect their company's productivity and the country's economic success in the global market negatively. This crisis would be a direct consequence of the nation's failure to educate and motivate the previous and current generation of students properly, particularly about the benefits of pursuing STEM careers.

The researcher hypothesizes that there are a variety of motivators, aligned with the values, beliefs, and attitudes of the target population, that have motivated STEM practitioners to embrace careers in the field. The researcher believes that it is possible to reverse the dwindling STEM participation and fill the growing number of new jobs in the field by motivating more students, especially those from traditionally underrepresented populations comprised of Blacks, Hispanics, Pacific Islanders, and Native Americans to pursue these careers.

The Stem Worker Shortage Problem

As discussed, the United States and possibly, the entire developed world may soon face an economic crisis that threatens people's current way of life. For many years, the economic success of many developed nations was premised on the innovation and creativity of their educated workforce, and his ability to drive those technological advances. Educational institutions, teaching techniques, and academic subjects have not been updated to keep up with rapid and ever-changing technological advances and scientific discoveries. For this reason, the country has failed in motivating students to pursue careers in those fields. A recent government report estimated that this trend could lead to a shortage of approximately 1 million STEM workers (Olson et al., 2012).

According to a 2017 report by the Pew Research Center, citing cross-national performance in the Program for International Students' Assessment (PISA), the U.S. was ranked 38th in math and 24th in science among 71 industrial nations around the world. Our production of college degrees in STEM programs is also lagging behind the number of graduates produced by China and India. It may not be long before we lose our global standing in the science and technology industries. There are many articles focused on the shortage of STEM workers that illustrate diverse perspectives about the STEM shortage issue. For example, there has been much discussion that the problem witnessed in STEM industries may simply be due to STEM workers lacking the new skills required by various industries (Rosen, 2013). A report by the National Science Foundation entitled *Revisiting the STEM workforce* noted that despite controversial views, there are many areas of consensus within the surplus-shortage debate. Analysts on both sides of the debate invariably emphasize the value of STEM job skills in boosting our economy.

Many analysts see a need to improve access to and the quality of STEM education at all levels. Addressing the STEM worker shortage would require a shift in the way that teachers currently instruct and in the subjects that are taught. The accelerated pace of technological advances calls for obsolete ideas to be left behind and for adjustments to curricula to be embraced. Technical obsolescence causes a mismatch between existing curricula and the rapidly changing interests and priorities of our students. Hence, schools are failing to leverage an important motivating factor, current students' interests that could encourage more students to pursue STEM careers. The gap between the number of STEM graduates that the country produces and the number of STEM workers that our economy needs to maintain its technological edge has increased steadily over the years. This gap is even wider when the low participation of underrepresented minorities, whose presence in STEM fields is well below their proportional presence in the general workforce, is considered. Although well-intended, the importing of talent from abroad creates another barrier that prevents our URMs from entering the STEM workforce (Collier, 2007). It is urgent to find actionable and effective motivators that would influence the next generation of STEM practitioners, particularly URMs.

Numerous analysts have also noted the need to collect additional data to improve our understanding of career pathways (National Science Foundation, 2015). By tapping into existing and the current research about motivating factors, researchers, practitioners, and policy-makers have an opportunity to address the problem of the STEM worker shortage. They also have the chance to close an opportunity gap by targeting URMs, an untapped source of qualified employees. Although racism and prejudice often influence the fate of nations, the United States, as a free, democratic, and highly-developed country, is well-equipped to offer equitable opportunities through its educational system to ensure the country's economic well-being.

Motivators

The studies and articles reviewed for this research revealed an overwhelming consensus that career decisions are influenced by a wide array of factors. Those factors have varying importance based on the demographic background of the students. While affluent students may be primarily motivated and supported by role models and direct influence within their family circles, economically disadvantaged students may place a higher value on achieving financial success and be more susceptible to their teachers' influence. The researcher listed the most frequently cited motivational factors within the reviewed literature that influenced established STEM practitioners, particularly URMs, to develop an interest for, pursue, and persist in a STEM-related career. The researcher used the motivational factors and barriers identified from the literature review as the framework for the design of the survey and interview questions for the current research. The existing scholarship served as a foundation for the formulation of conclusions and recommendations that could shape policymaking and promote the implementation of effective programs that would have measurable outcomes. The literature review also allowed gaps in the research to be identified.

There are many research-based hypotheses, suggestions, and assumptions made about the factors that motivate students to pursue STEM careers. However, there is a lack of empirical research available that spell out how these factors influence career decisions. For example, it is well-known that parental influence is critical to the decisions that young adults make; however, the type of parental input and the triggers that led to these decisions are not well-documented. A further example is provided by a research study of 7,813 Grade 9 German students (Taskinen, Schütte, & Prenzel, 2013). The authors found that school-related variables were extremely relevant to students' interest in science and science self-concept (Taskinen, Schütte, & Prenzel, 2013). Although the study addressed school factors broadly, it neither identified the specific factors that influenced career decisions nor explained how they exerted their influence. This section presents a list of motivating factors that have been most frequently cited in the literature.

Parents/Family Influence

The most frequently cited factor influencing career decisions was the impact of parents and family (Johnson, 2014; Tillman, 2015). From encouraging children to exposing them to specific career choices, parents and family members are often the main reason children choose a line of work (Garikai, 2018; Joseph, 2012; Lloyd, Gore, Holmes, Smith, & Fray, 2018). Research reveals that "values, beliefs systems, and family support can influence girls' interest and success in STEM fields" (Wang & Degol, 2013, p. 14).

Teacher/School Influence

The educational setting and those in it often play a big role in exposing children to career choices and giving them the confidence and self-efficacy needed to pursue them. (Oymak & Hudson, 2009; The National Academies of Sciences, Engineering, Medicine, 2018). By implementing programs and enforcing policies, they often guide their students into successful careers (AllAboutSchoolLeavers, 2016; Glaze, 2016; Mittendorff, Beijaard, Brok, & Koopman, 2012). Those recommendations include a call for more STEM professionals entering the education field and teaching our next generation of students. They advocate that a "Meaningful preparation of K-12 and higher education STEM faculty should be considered as an undoubted necessity to meet the needs of a scientifically and technologically literate workforce in a modern and technology-driven nation" (Hossain & Robinson, 2012, p. 450).

Peer Pressure

By living with or being surrounded by individuals that are career-minded, children can be pushed or influenced to pursue similar professional goals. By witnessing these people's positive career progressions and the benefits they draw from their professions, children can be inspired to emulate them (Alika, 2012; Scholastic, 2008).

Role Model

One particular person or group of people can change the life course of an individual by setting an example that he would admire and want to follow (Lee, 2011). Unfortunately, STEM role models are overshadowed by idols fabricated by popular media such as musicians, and actors who often give the wrong example through their unacceptable work ethics and poor moral character (Shin, Levy, & London, 2016; Van Raden, 2000)

Early Immersion into STEM Education

Researchers have diverging opinions on the right time to expose children to a specific subject, such as STEM (Roberts et al., 2018). However, they all agree that the earlier children are exposed to these topics, the easier it becomes to embrace them (Kesar & Halcombe, 2019). This early exposure is often the key to the self-efficacy needed to make career choices (Eagan et al., 2013; Estrada, Hernandez, & Schultz, 2018; Mitchell, 2011).

Media/Entertainment

The way specific characters are portrayed by the media can have a lasting impact on the young minds of students. In particular, the advent of social media has provided an unprecedented platform for opinions and ideas to be shared instantaneously and globally. Exposure through movies, newscasts, TV shows, and sporting events have shaped the way people see specific careers and professions (Bhatt, Mohanty, & Payne, n.d.).

Success/Wealth

The expectancy-value theory emphasizes how expectations of success and the value we place on that success can impact career choices significantly. Several articles mentioned success and wealth as the leading factors influencing decisions to choose STEM careers. Research suggests that financial assistance supports the participation of URMs in STEM (Cabrera, Nora, & Castaneda, 1993).

Social Status

The social cognitive theory similarly recognized the importance of students' upbringing. It also pointed out the influence of the social, environmental setting in decisions involving career choices. The people with whom a person grows up, and his neighborhood shapes the person he becomes (Cabrera, Nora & Castañeda, 1992).

Personal Challenge

A single event or a pervasive condition, such as bullying, or discrimination can provide the incentive and create the determination to pursue a goal beyond expectations. Challenges to prove others that you are that much better, or that you can achieve much more than they believe you can, is a powerful force that can lead to amazing accomplishments (Cannady, Moore, Votruba, Greenwald, Stites, & Schunn, 2017).

Innate/Personal Interest

Sometimes, people say that an individual is “destined” or “was born” to be in a certain position. However, the decisions made by an individual are shaped by his experiences, environment, and the exposures he has had throughout his life. Some of the fixed conditions the individual experienced from birth through adolescence could predict his professional and personal outcomes, although these predictions could be derailed by small, unplanned events or unpredicted variables. The events and the environment shaping those personal interests are often fixed. When the predicted outcomes are realized, these personal interests often appear innate and predictable (Carpi, Ronan, Falconer, & Lents, 2017; Shulruf, 2010).

Government Program or Policy

The availability, effectiveness, and implementation of programs and policies can sometimes make a difference in the career choices of students. There are many industry- , government- and privately-funded programs that are aimed at increasing the participation of students, particularly URMs, in STEM and promote general awareness of STEM fields. However, they are not implemented everywhere, for everyone, and with the same level of effort. By taking part in these programs or being the beneficiary of these policies, many students have learned about and taken advantage of opportunities that they would otherwise never have come across (Handelsman, & Smith, 2016; Howard-Brown & Martinez, 2012).

Barriers

The sample population used in this study represents successful STEM practitioners, so it may be more challenging to identify and validate the barriers that discouraged or derailed the professional goals of other STEM students accurately. Nevertheless, the current study accurately identifies the barriers that successful URMs faced and were successful at overcoming. By reviewing the literature, the researcher examined the barriers that have already been identified by other studies; however, the validation of those facts is not within the scope of this study.

According to an article published in BioScience magazine in April 2012, “about 20% of URM students aspiring to major in a STEM discipline end up completing a STEM bachelor’s degree within five years” (Hrabowski, 2012, p. 1). These rates are low compared to rates for Whites and Asians, which are 33% and 42%, respectively. These statistics point out that a large majority of our students fail to adapt and overcome the academic and social obstacles they face after graduation from high school. According to Tsui (2007), obstacles experienced by URMS can be cultural (societal expectations for different groups), structural (historical laws and regulations that barred the entry of minorities into education and employment), and institutional (discriminatory policies and practices). Some of the main barriers experienced by URMs and others are listed in the subsequent sections.

Parental/family factors

Giving our children praise and encouragement helps build their self-efficacy and expectancy for positive results. By not encouraging, praising, and recognizing learning accomplishments, parents can miss an opportunity to build self-confidence and the self-efficacy needed to make their future career decisions. As outlined in the Nora et al. model, the school and home environment can also influence URM to persist and attain their academic goals.

Financial Hardship

The high cost of education is often cited as the main reason many students do not pursue a STEM career. It has driven away many students equipped with the required academic skills and aptitude to be successful in those fields. A students’ low socioeconomic status can make postsecondary education a luxury. Lack of exposure to methods of financing can truncate the dreams of many students that otherwise would have been successful STEM practitioners.

Lack of Resources

Depending on the poverty level of the school and its students, many bright and promising young scientists are denied resources that are usually available to more affluent schools. This lack of accessibility hinders students' ability to learn and to compete on a leveled playing field. Resources such as access to technology, well-equipped laboratories, and properly trained and experienced instructors can make a major difference to the attitudes and dreams of students.

An article by the Institution of Engineering and Technology published in 2008, entitled studying STEM: what are the barriers? addressed the choices that students make and what factors turned them away from pursuing STEM careers. That study identified the lack of inspirational and quality teachers as one of the primary reasons for which students are not motivated to join STEM careers.

Lack of Exposure

You can never aspire to be something that you do not know anything about or have never seen; that is why a career in STEM begins with knowing about STEM. Many students and young folks grow up in environments where certain fields and careers are considered "for others," and they end up never getting to experience it or learn about it. STEM appears to be one of those areas, especially if there is no one at home that can raise that possibility, or the school curriculum fails to expose all the students to this career option.

Misinformation

Media, peers, and often family members give their opinions about specific careers and professions, casting inaccurate and negative images that are perceived as real. Those images can make a difference between what we choose to do, and what we choose to stay away from.

There are many social stigmas associated with scientists and engineers, and; many of our students do not perceive those professions as "cool."

Discrimination/Racism

Biased attitudes towards certain segments of society have also been associated with barriers that can keep URMs from pursuing STEM careers. These barriers manifest at every stage of life, from early education to college; and even in the workforce. Students can be discouraged from pursuing a career in those fields when they witness racism and discrimination, hampering promotions and opportunities for hiring.

Discouragement

The comments of those closest to us can many times shape the way we think about ourselves, and place boundaries on what we can and cannot do. Negative comments at home telling the children that they are "bad at math" or that "they are not smart enough" to accomplish a certain task adversely affect how they think of themselves and shape their self-efficacy and career goals. Teachers and counselors can also do the same by labeling students and telling them that a certain class or a certain area of study would be too difficult for them based on subjectivity or biased opinions.

Fear of Difficulty/Failure

The perceived difficulty associated with STEM can discourage students from pursuing STEM careers (The Institution of Engineering and Technology, 2008). Failure has always been seen negatively, especially in schools where grades designate who is "smart" and "who is not smart." When a student or an individual lacks the confidence to try something new because he has doubts about his ability to succeed, he experiences fear. This fear, coupled with the level of difficulty associated with STEM topics; deter students from trying to integrate these fields.

Negative Social Image

The expectancy-value theory recognizes perceived cost as a very important factor in decision-making. Cost is defined as what we give up in exchange for pursuing a specific task. Social status is very important, and social media has made this issue even more visible. Going into STEM fields and being good at it can be seen as a way to "losing being cool" and "becoming a geek or a nerd." Many students are bothered by this potential change in image and thus choose to ignore their potential to belong to a cooler crowd.

Peer Pressure

The people that one associates with makes a big difference to whom one becomes. Often decisions are shaped by the opinions of those around us; a wrong association can lead students into the wrong life path. Gangs, drugs, and crime have lured many promising students away from promising careers because those around them ridiculed or shamed those students into staying away from the positive life path. Negative views and stereotypes about careers and opportunities in STEM can deter students from entering STEM professions (The Institution of Engineering and Technology, 2008).

Inadequate programs

A March 2011 study conducted by the University of Massachusetts, Donohue Institute for the Massachusetts Department of Higher Education, for profiling STEM pipeline programs, reported the inadequacy of STEM programs, which aimed at boosting interest in these fields. This report not only portrays the multiple programs that are out there but also highlights their lack of aim and direction as well as the fragmented strategies that were used in their inception. The resources that have been dedicated to these endeavors continue to be wasted by the fragmented and disjointed efforts that have taken place over the last few decades. It is pressing to set up programs whose effectiveness can be measured, which includes less rhetoric and more accountability (Chang, Sharkness, Hurtado, & Newman, 2014). Our goal should be to unify common efforts in this area, creating a policy and program with measurable outcomes.

Engaging Students in STEM

Some articles attempt to simplify the issue of STEM employee shortage by offering ready-to-apply solutions that may, on the surface, appear easy to implement. However, they are way more complex, expensive, and difficult to put in place in practice. For example, an article on the website STEMJOBS provided the following tips for engaging minority students in STEM: (a) Start minority students off early in STEM programs; (b) Increase minority students' access to STEM resources; (c) Have students engage in minority STEM programs and organizations; (d) Allow students to see other minorities in their STEM fields as role models; and (e) Help minority students find STEM scholarships (Legacy Posts, 2016). Although these are well-intended and altruistic solutions, there is a need to design and implement practical solutions that go beyond theoretical ideas to produce tangible and measurable results. Practitioners and policy-makers should identify and implement simple but effective solutions that can have a direct positive impact on career decisions; otherwise, the goal of equity and diversity will continue to evade us.

A contrasting approach to engaging more URMs into STEM suggested by Tsui (2007) was to target interventions at the overall STEM student body, rather than limiting efforts to URM STEM students. This can help avoid stigmatization and "spotlighting" (Tsui, 2007). A combination of strategies could be used to support the academic, social, and professional development needs of all students (Tsui, 2007). Although this strategy has some merit, the study does not provide enough evidence to make it the universal solution that could be implemented everywhere and by everyone.

In 2007, an article in The Journal of Negro Education summarized a review of the research literature in the area of effective strategies to increase diversity in STEM. In that article, they pointed out the various factors and barriers that contributed to the disproportionately low participation of URM in STEM fields. The author identified obstacles such as cultural (societal expectations for different groups), structural (historical laws and regulations that barred the entry of minorities into education and employment), and institutional (discriminatory policies and practices) barriers.

Another strategy for encouraging more students into STEM is to ensure adequate preparation of students. One question that has been raised is whether students are adequately prepared for the rigor and expectations of the job market. Teachers need to be careful about allowing students to think that they are ready when they might not be. Feeling isolated and unprepared often leads to a lack of self-confidence and doubts about self-efficacy. The cultural shock that many students face while going from high school to college can be alleviated by the use of focus groups that can address the cultural change by exposing students to the different perspectives of faculty, staff, and students regarding the causes of achievement or lack thereof. "Culture change requires careful self-reflection, robust dialogue, and rigorous analysis, to understand trends in academic performance as a result of intervention strategies" (Hrabowski, 2012).

Underrepresentation of Minorities (URMs) in STEM

It was estimated by the U.S. Bureau of Labor Statistics that by 2018, the STEM workforce in the U.S. would be 8,650,000 strong, with a yearly rate of increase of 17% from 2014 to 2024 (Langdon, 2011). Considering that there are two-thirds of new jobs that need to be filled, it would be wise to harness the potential of girls and underrepresented minorities, which make up 50% of the K-12 population (Ouimet, 2015). During the Obama administration, several initiatives were carried out to bring the issue of URMs in STEM to the forefront. A report by the U.S. Commerce Department Economics and Statistics Administration attributes a large part of the blame for the underrepresentation of particular minorities in the STEM fields to the lack of equality in educational opportunity (Beede et al., 2011). This report was the third in a series of reports issued by the administration, which was focused on the demographic composition and educational backgrounds of people in STEM jobs in the U.S. economy. It placed emphasis on the importance of higher education for minorities seeking to achieve equality of opportunity in the workforce. The report also gave a comprehensive picture of the ethnic composition of the STEM workforce; only 22% of non-Hispanic Blacks and 14% of Hispanics had bachelor's degrees; while 54% of Asians and 35% of non-Hispanic Whites had that level of education. Some of the key findings of this report include:

1. Seven out of ten STEM workers are non-Hispanic Whites, which aligns closely with their share of the overall workforce;
2. Non-Hispanic Asians are the most likely (42%) to graduate college with a STEM degree;
3. Half of all non-Hispanic Asian STEM degree holders go into as STEM job but the likelihood is lower (30%) among Hispanics and non-Hispanic Black, American Indian, and Alaska Native workers;
4. Sixty-three percent of foreign-born STEM workers come from Asia, with most from India or China (Strauss, 2011).

The United States Census Bureau issued a report in 2013 entitled *Disparities in STEM employment by sex, race, and Hispanic origin*, in which Liana Christin Landivar, the author, points out that "Blacks and Hispanics have been consistently underrepresented in STEM employment. In 2011, 11% of the overall national workforce was Black, while only 6% of STEM workers were Black. Although the Hispanic composition of the national workforce was 15%, they only made up 7% of the STEM workforce. While these underrepresented minorities fall below the expected proportionality levels, the STEM fields are overrepresented by Asian minorities which make up 19% of scientists and engineers while only making up 5% of the general population (Landivar, 2013). A 2014 U.S. News and World Report article also addressed the level of representation of various ethnic groups in the STEM workforce, as compared to the general workforce. This 2014 study supported the findings of several other studies. It reported that Asians made up 19% of the scientists and engineers in the U.S., while only representing 5% of the general population. In contrast, African Americans, Hispanics, American Indians, and Alaska Natives only accounted for 10% of the science and engineering jobs, while making up 26% of the general population (Neuhaser, 2014).

Although there has been a multitude of studies exploring the causes of the underrepresentation of URMs in the STEM workforce, there has been limited progress made in increasing their participation in STEM. Although this lack of interest in STEM fields crosses ethnic and demographic boundaries, the level of underrepresentation by particular minorities is more pronounced. For example, according to Maria Klawe (2015), a contributor for Forbes Magazine "African-American, Latino and Native American students still lag far behind their White and Asian counterparts in terms of their participation in math, science and engineering fields." She points out that some of the main barriers that these minorities face are directly related to the lack of proper and sufficient access to quality math and science education during their K-12 school years. These challenges are exacerbated by the lack of resources available to districts serving lower-income and minority students (Klawe, 2015) and the upbringing provided by single parents, or parents that do not have the education to guide and tutor their children properly.

Although there has been some progress over the last few years, more needs to be done to increase the composition of URMs in STEM. There are still concerns about the lack of proportional representation of minorities in the STEM workforce, more specifically about the high propensity for them to avoid entering or drop out of STEM programs. According to an article by the National Academies (2011), minorities especially those who are potential first-generation college students, “have insufficient information about educational and career opportunities and options at critical decision points in middle and high school” (National Academies of Science, National Academy of Engineering, & Institute of Medicine of the National Academies, 2011). The same article also points out that the postsecondary admission process is often too complex and overwhelming for those that do not have the education, familiarity or skills to understand it; often discouraging them from applying or even considering that option (National Academies of Science et al., 2011).

Despite the efforts put in and the resources spent by the industry and the government in trying to close the gap and bring equity and demographic balance to the STEM workforce, it was revealed by a report of the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine (2010, p. 1) that the outcome was not satisfactory. It stated that “America’s competitive position has deteriorated further.” If effective and inclusive solutions with measurable and tangible results are not implemented soon, the situation will get worse, posing an economic threat to our country and our way of life (Singer, 2011).

Many may ask why diversity is needed in the workforce. The answer can be as morally simple as it is the right thing to do. A more complex and scientific answer may be that the makeup of the workforce decides the solutions to our economic and societal problems (Rozek, Ramirez, Fine, & Beilock, 2019). According to an article by Camera (2017), most underrepresented minorities have a lack of familiarity with STEM careers or people working in those fields, as well as a lack of strong scientific and math background training. Houshang Darabi, an engineering professor at the University of Illinois at Chicago, has advocated for an equal playing field, which offers fair competition to both URMs and non-URMs. He clarifies his point about URMs: “Nobody is saying that we should give them everything that they need without competition, but at least give them the same training and then say how you compete so that the competition is fair.” (Prax, 2017). This statement can serve as basis for decisions and policies aimed at helping people in getting a fair opportunity of choosing and integrating a career, hopefully in STEM (Prax, 2017).

Although fair access to STEM is an important consideration, there are other related issues that deserve attention. One concern is the impact of failure on the self-efficacy and decision-making ability of students when faced with the challenge of choosing a career or pursuing higher education. The type and amount of failure that children and adolescents go through vary depending on their socioeconomic status, ethnicity, and cultural backgrounds. There is a perception that URMs face bigger and more critical challenges than their more affluent counterparts. This perception leads to the assumption that they also experience failure in higher proportions. Failure traditionally has a negative connotation and is perceived as something that should be avoided. The impact that multiple instances of failure may have on students’ self-confidence, and how they may erode self-efficacy in difficult areas such as STEM is worth considering. One of the solutions may be to nurture a growth mindset, which would turn the negative perception of failure around into an opportunity to learn. It has been argued that failure has the “potential to promote creativity and innovation,” since it is part of a cyclical process where the students experience “small successes and frequent mistakes” (Maltese, Simpson, & Anderson, 2018, p. 3). The negative perception of failure can be changed, and the acceptability of mistakes promoted, thus mitigating one of the factors that affect career decisions and self-efficacy adversely, especially among URM students who are targeting STEM careers (Simpson & Maltese, 2017).

Another deterrent to URM attainment of STEM degrees is the affirmative action practice, which allows students, not meeting academic standards, to be admitted into programs and institutions based on their URM status. Richard H. Sander argues that "policies that increase selective universities' minority enrollment by admitting applicants with test scores and other credentials well below the average of the admitted class systematically put minority students in academic environments where they feel overwhelmed and inevitably, struggle" (Sanders, 2004, p.481). Care should be taken about the way attempts are made to close the gap; closing the gap involves more than pushing the students to perform at a higher level. They should be in an environment in which they feel comfortable and confident so that they can excel (Benderly, 2012).

Persistence, or the lack of it, also contribute to the leak in the STEM workforce pipeline. Although this issue impacts individuals from all demographic backgrounds in the STEM fields, it appears to hit URMs harder as the number of graduates among this population is already low. An article in Business News Daily brought to the fore alarming statistics reported by the Census Bureau's Industry and Occupation, revealing that 75% of science and engineering graduates were not working in STEM occupations in 2011 (Landivar, 2013). Instead, they were working in such fields as non-STEM management positions, law, education, accounting, and STEM-related occupations such as health care ("Women and Minorities Underrepresented in STEM Jobs," 2013). Besides addressing the motivating factors that attract students into STEM careers, it may be worthwhile to investigate the reasons for which individuals moved away from STEM jobs, despite having science degrees. Although the shortage of students majoring in STEM is a concern, having qualified students shy away from those jobs points to a more acute systemic problem. It was documented in a UCLA research brief in 2010 that four-year STEM degree completion for Whites and Asian-Americans were 24.5% and 32.4% respectively; while for Latinos, Blacks and Native Americans, they were 15.9%, 13.2%, and 14.0% respectively (Abdul-Alim, 2013).

URM students often face different and additional institutional and societal barriers to educational opportunities, such as discrimination in their path to the STEM workforce. Grossman and Porche (2014) attempted to address some of these issues by looking at urban adolescents' perceptions of gender and racial/ethnic barriers to STEM success, and how they coped with those experiences. The authors' analyses revealed evidence of "microaggressions" towards URM students and reported the responses to these microaggressions. They appeared in the form of verbal, non-verbal, and environmental manifestations (Grossman & Porche, 2014). They were further labeled as micro-assaults, micro-insults, and micro-validation. These attacks, which are often unconscious, have significant negative impacts on URM adolescents, increasing their level of anxiety, anger, and stress. This concept of microaggression is directly related to the students' perception of racism and discrimination. However, the study also showed that the students were optimistic about overcoming these obstacles. It additionally reported that positive figures or role models could mitigate the negative effects of such attacks.

URMs have specific needs that need to be met to encourage their participation in STEM. An article in the Journal of College Science Teaching highlights the environments in which minority students achieve best (Kendricks & Arment, 2011). Minority students achieve superior academic performance in diverse learning settings that emphasize the importance of addressing both the student's social and academic needs (Kendricks & Arment, 2011). Based on the expectancy-value theory, expectation of success influences students' academic attainment and their choices related to achievement (Meyer, Fleckenstein, & Köller, 2019; Wigfield, 1994). It starts with the students' beliefs of self-efficacy in accomplishing a task or pursuing a specific career, followed by an assessment of the value associated with the task or effort. However, the most important finding of this study was that societal support was critical to the URM students' self-efficacy and the expectations they set for themselves. For example, the expectancy-value beliefs of those students were directly attributed to the positive socialization and nurturing provided by parents, teachers, peers, and schools, as well as the stereotypes and perceptions that others hold. They identified six key elements as critical environmental factors to the persistence and success of URM students in STEM (Kendricks & Arment, 2011). They are: (a) supportive family environment, (b) caring teachers, (c) high expectations, (d) academic rigor, (e) dynamic classroom strategies, and (f) discipline (Kendricks & Arment, 2011).

Although most initiatives aimed at promoting greater participation of URMs in STEM have failed to produce measurable outcomes, some have merit. A national longitudinal study (Hurtado et al., 2010) was directed at identifying social and institutional factors as well as the principles of good practice that shape the URM's educational decisions. The idea is to ultimately "develop initiatives that aim to reverse the negative trends observed in the American science pipeline." The study revealed that there were "significant effects related to the relevance of science course work, racial climate, cross-racial interactions, and financial concerns. These findings led to the conclusion that there is a very strong correlation between science course work and the students' lives. It also highlighted the significant role that academic and social adjustments play in the success or failure of URM science students (Hurtado et al., 2010).

Another good example of well-intended efforts to increase STEM participation is provided by a qualitative study used to examine the impact of the Oregon HB 3072, a postsecondary STEM Grant, dispensed by the Higher Education Coordinating Commission during the 2016-2017 school year (Clements, Hodaie, & Schaack, 2017). This study performed by a student at the University of Oregon aimed at answering four basic questions. They were: (a) What are the promising practices to recruit and retain women and minorities in STEM?; (b) What are the impacts of these promising practices on students?; (c) What are the challenges that programs face in achieving their goals?; and (d) What are the future directions of these programs? Although time and resources were spent, and very valuable information about challenges and promising practices was obtained, the results never made it to the real world, thus they had no significant impact on the STEM crisis (Clements et al., 2017).

Another area of concern that resonates throughout the literature is the emerging need to educate and inspire our students to embrace STEM careers. William Butler Yeats stated: "Educating isn't the filling of a pail, but the lighting of a fire" (Strong, 2013). In the same line, Blair Christie and Eric Schwarz (2017) reiterated the important role of inspiration:

> We need to light the fire and inspire our young people to explore the incredible world of science, technology, engineering and math. We need to encourage young people from all backgrounds to participate in hands-on STEM projects. It is difficult to dream about something that you have never seen. (p. 2)

It is important to expose young students to the fields that need to be filled in the future, so the economy thrives. Exposure and interest complement one another, especially if the exposure is a fun and positive experience. The interest of eighth grade students is a considerably stronger predictor of the ability to graduate with a college STEM major than the expected achievement of older students. It is thus essential to expose students to and educate them about the magic of science early in their lives. They should experience the rewards of carrying out hands-on experiments and finding solutions to real-life problems. There is also a need to make the playing field more equitable by identifying and breaking down the barriers that hinder URMs from joining the STEM workforce. As cited in Tinto's theory and model of student retention, there needs to be "tailored interventions to meet the needs of specific cohorts e.g., transfer students, academically "at-risk" students, "non-traditional" students (Christe et al., 2015).

CHAPTER 3: METHODOLOGY

This chapter describes the procedures that the researcher followed to collect and analyze the necessary data accurately and to formulate valid and actionable conclusions and recommendations. The practical problem that justifies the current study is the STEM employee shortage, which could be addressed by tapping into the pool of URMs. According to a 2013 study at Colorado State University, aimed at addressing the sustainment of the optimal motivation, the numbers of African American and Latino students opting for scientific or engineering fields of the education pipeline or embracing STEM careers, are particularly minor compared to their White and Asian counterparts. The authors outlined the basic motivational theories that have been used to explain and expand on the understanding of the factors behind the career choices, while emphasizing the "leaky science degree pipeline problem" (Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013).

The literature review revealed research gaps that the current study sought to address. There is a shortage of research on actionable motivators influencing STEM practitioners to pursue their careers. A 2013 study carried out by the Colorado State University pointed out the lack of research focusing on the factors that maintain or encourage optimal motivation of URM students, especially STEM students, in their goals over time. There are broad categories of motivators that have been identified; however, these factors seem to lack specificity and practicability, which makes it difficult to translate into actionable and measurable policies and programs. The current study addressed this research gap by identifying the direct motivators (who and what), which triggered the students' decisions to go into STEM professions. These influences can then be made into easy-to-implement policies and practices that could be disseminated to homes, schools, and communities to educate as many people as possible about ways to motivate the next generation of students into STEM. The theoretical frameworks used in this study were a combination of the expectancy value theory, and the social cognitive theory, which allowed the researcher to examine the motivators leading STEM professionals to pursue their professions. The study also explored the potential differences between the factors affecting URMs, and the rest of the population, in the context of motivators and barriers. The researcher used the existing literature on the topic as well as the theoretical frameworks to formulate the survey questions which aimed to collect information about the motivators and barriers experienced by individuals in their journey into STEM careers. The study targeted STEM professionals, particularly URMs. Once the target population was identified and surveyed, the responses were coded and analyzed using a mixed method approach that merged quantitative and qualitative analytical techniques. The quantitative items from the survey were recorded as independent and dependent variables. Interval data were analyzed using multivariate analyses such as Pearson correlations and Analysis of Variances (ANOVAs). Categorical data were analyzed using statistical methods such as Chi-Squares.

The researcher carried out the current study using the following guidelines:

1. Identify the problem of practice
2. Research the literature and find the “gap.”
3. Create a hypothesis and a central question.
4. Develop a theoretical framework
5. Formulate research questions
6. Develop the instrument (Mixed method).
7. Identify the sample population.
8. Obtain IRB concurrence and permission from the participants.
9. Distribute the online survey.
10. Tabulate and code the responses.
11. Analyze the responses.

12. Draw findings and conclusions from the analysis.
13. Summarize and create conclusions.
14. Write the report and provide recommendations.
15. Publish the report.

Method

The current study followed a predominantly quantitative research design. Some open-ended qualitative questions were, however, included in the research instrument used in this study.

Sampling

The STEM industry is composed of an array of fields and specialties, with careers that range from very narrow and unspecialized low skill jobs such as "field technicians," to more complex and highly trained jobs such as "engineers, doctors, and scientists." It was thus important for the surveyed sample to be an acceptable statistical representation of that population. A stratified purposive sample of participants was obtained from various STEM professions by soliciting participation from over 100 specific professional and sub-professional STEM organizations. "Stratified sampling is used when you want to ensure that the characteristics of the individuals (and potential research sites) included in the sample are representative of the characteristics of the individuals (and sites) in the broader population" (Lochmiller & Lester, 2016, p. 144). Care was taken during the recruitment of participants to preserve the structural and demographical makeup of the existing STEM population by targeting STEM professionals, particularly from URM groups, that work in different STEM-related professions. This ensured that information about factors influencing different subpopulations, such as scientists, physicians, engineers, teachers, nurses, technicians, lab assistants, researchers, especially URMs, were systematically collected. The sampling targeted only those subjects that had achieved their career goals.

Sample Size Selection

The size of the sample was determined by two primary factors: the response rate to the solicitation letter, and the participation from each of the target careers. A minimum sample size of 800 subjects was targeted. For survey research, where the participants are recruited from very large populations such as superintendents, secondary principals, elementary principals in the United States, it is recommended to aim for 800 or more participants (Lunenburg & Irby, 2008). The researcher contacted about 100 professional organizations across the country in the hope of receiving 8 to 10 responses from each of them from participants representing various professional levels and disciplines. The researcher was able to recruit 318 participants. Although this is lower than the number that was initially targeted, the sample was nevertheless fair, allowing the researcher to have enough statistical power for quantitative analyses. This sample included responses from participants from the four STEM disciplines, from entry-level to professional status.

Instrumentation

The sample was surveyed using an online questionnaire built on SurveyMonkey. The researcher chose several variables to be included in the questionnaire. The variables represented various specific motivators that influenced STEM practitioners to pursue a STEM career. The motivators were selected based on the frequency at which they appeared during the literature review and the level of importance they were assigned by other researchers. The choice of the construct was also governed by the theoretical frameworks used in this study, the expectancy-value and social cognition theory. There were five distinct constructs: demographics, parental/family influence, school/teacher influence, perceived benefits, and perceived barriers. The questions within these constructs were designed to provide analyzable data that could help identify the "what" and the "who" that influenced the participants into a STEM career. The dependent variable in this study is the decision to choose a particular STEM career, while independent variables are the “what” and the “who” that motivated those decisions.

The early versions of the questionnaire included different types of questions, such as multiple-choice, open-ended, ranking, and Likert scale questions. Based on the developing literature review, the variables and constructs were refined and redefined by the researcher. The survey questions were simplified to include multiple-choice, Likert scale, and open-ended questions to limit the data collected to interval data and open-ended responses. The final version of the research instrument was made up of 43 questions divided into four sections: demographics, high school experience, college experience, employment or professional experience. There were a total of 43 questions; ten demographic questions, 13 Likert scale questions on a 5-point Likert scale, six multiple-choice questions, and nine fill-in the blanks. The Likert scale options ranged from *completely agree* (5) to *completely disagree* (1). The research instrument also included five open-ended questions about participants’ experiences during high school, college, and employment or professional care. The questionnaire was sent to the potential participants by email, accompanied by an attached participation request letter, informing them of the purpose of the research, the potential benefits their cooperation could bring as well as any possible risks they could incur by participating. Table 1 shows the constructs used as well as some sample questions included in the survey.

Table 1

Sample Questions Included in Questionnaire

Constructs	Number of questions	Sample questions
Demographics	10	What is your age?
Motivators	5	To what extent would you agree that the following was the primary reason you pursued a career in STEM?
Barriers Faced	5	To what extent would you agree the following dissuaded you from pursuing a career in STEM?
Influence Factors	6	To what extent would you agree the following influenced you to pursue a career in STEM?
General Information	17	What high school did you graduate from? What were your ACT and/or SAT test score?

The researcher ensured that the instrument measured the content area and the constructs targeted by asking questions that addressed the elements contained within the theoretical framework of the expectancy value theory and the social cognitive theory. The constructs were selected to identify the value and the costs associated with the decision to pursue a STEM career, as well as the environmental factors that shaped that decision and contributed to the respondents' self-efficacy in the area of STEM. The demographic (ethnicity, age, socioeconomic status, gender, and geographic location) questions were aimed at trying to identify the potential specific traits exhibited by Underrepresented Minorities (URMs), as compared to Non-URMs. The researcher also attempted to use concurrent and predictive validity of the data, by running correlational analyses of potential motivating factors between the various participants, including the URMs, and Non-URMs. Reliability, which measures the consistency of the constructs that an instrument is supposed to measure, can be maximized by ensuring that the questions are free of personal and location induced biases. A pilot study was conducted to ensure biases or confusion was identified prior to the final deployment. The researcher used a comprehensive review of the literature to select the motivational factors that would be measured by the questionnaire to ensure that they were relevant to all individuals being surveyed and were free of biases. Additionally, that reliability can be maximized by ensuring that the raters and scorers are properly trained and free of biases. In this particular case, no additional rater was used.

The open-ended questions included in the online survey constituted the qualitative portion of this study. The researcher also requested permission from the participants to be contacted in the future for interviews if clarification or additional information were needed. The group who agreed to be interviewed at a later time was, however, small and was not considered in the current research.

The open-ended questions were formulated around the following central ideas:

1. Why did you choose to pursue a STEM career? When did you make that decision?
2. What was the single most important influence that made you choose your STEM career? Do you remember how it happened?
3. Who was the most influential person guiding you to pursue a STEM career?
4. What significant event triggered your interest in STEM? How?
5. How would you describe the social environment that helped you consider STEM as a career choice?
6. What were the benefits that you expected from majoring in a STEM field? Have you realized those expectations?
7. What cultural factors influenced you to pursue the STEM pathway? How so?
8. Did anyone or anything open your eyes to the possibilities of STEM at any time during your primary or secondary education? Describe the event.

9. What expected values did you attribute to a STEM career prior to deciding on a career choice?
10. What costs or sacrifices did you associate with a STEM career as you were making that choice? Why did you still choose STEM?

Answers from each of these questions were compiled into a word document. The researcher organized the document by responses and was ready to code for similarities using a grounded theory approach. The open codes were to be combined into axial codes, and a narrative was to be created in the last coding round, the selective coding. That narrative was to supplement the findings and conclusions derived from the quantitative research phase of the study. Unfortunately, due to the large amount of very valuable data received, the researcher concentrated on the Quantitative Analysis, and minimized the Qualitative Analysis, by directly interpreting (verbatim) the answers to the open-ended questions.

Data Collection

The online questionnaire, a solicitation and explanation letter; as well as a consent form, was sent electronically to over 100 STEM professional organizations for optional delivery to their members. Potential participants were informed of the purpose and objectives of the study, the potential benefits, the background and potential biases of the researcher, the design/methodology being used, as well as their right to pull out of the survey at any time. The letter emphasized that their data would be handled with full confidentiality and that the responses to open-ended questions would be coded by qualified staff, who would be trained for consistency and standardization. The survey was deployed in the middle of March 2019, and it closed in mid-August 2019, over a total of five months of data collection. The participants were asked to follow a specified link where the online survey was made available. After the participants had returned the completed surveys, they were solicited to participate in follow-up interviews. This second round, unfortunately, had a low response rate so, the qualitative interviews were not considered as part of the current study. Some telephone interviews were performed by the co-researcher of the current study; however, the data was not coded and analyzed statistically using a qualitative approach. The responses were recorded as anecdotal, and interpreted as individual stories.

Validity and Reliability

Validity and reliability are terms that are primarily derived from quantitative research approaches; they have particular meanings when used in qualitative work. These terms "employ postmodern and interpretive perspectives, consider validation as unimportant, combine or synthesize many perspectives, and visualize it metaphorically as a crystal." The researcher embedded strategies to increase validity and reliability as from the start so as not to put the quality of the research in jeopardy. Similar research processes as a dissertation study by Michael F. Minutello (2016) from Pennsylvania State University were used in the current study. While Minutello's 2016 study addressed the reasons for which students left the field of STEM, the current research examined the motivational factors behind individuals' decisions to enter the STEM field. In the study, only 20 students were interviewed, while in the current study, a quantitative approach was used, and several hundred practitioners were surveyed (Minutello, 2016).

The survey was given to and completed by 52 acquaintances and colleagues of the co-researchers during the pilot study, for validating the clarity and effectiveness of the questions. Based on the feedback, minor adjustments were made to the instrument before the final deployment. Reliability is defined as the degree to which data consistently measures its subject, time after time (Concordia University Irvine, n.d.). To promote consistency and reliability, the researcher addressed three main sources of error. They were: (a) subject errors due to different states of mind of participants; (b) subject biases due to participants' propensity to please the researcher; and (c) the participants' errors and biases as he is influenced by his own expected results (Gibbs, 2015). These areas of concern were addressed by identifying any potential variances attributed to the subjects' attitudes or environment/settings early and ensuring they were comfortable and not pressured in providing pleasing answers. The researcher ensured the survey was easy to understand, so participants could answer it at their convenience in any setting. The survey was administered online, so participants were free to complete the survey at their convenience, in the absence of the researcher. The observer and researcher need to also identify and disclose any biases or prejudice that he/she brings to the study (Golafshani, 2003). The researcher included a section in the current chapter to outline his perspective. A full disclosure statement on the researcher's position on the STEM crisis and his background as a professional engineer and engineering instructor in a Title I high school are included.

Validity is often defined as obtaining data that genuinely represents the objects or subjects to be measured. Internal validity is encouraged when the researcher attempts to match as closely as possible the reality that he is trying to measure. Besides using adequate sample size, the researcher applied other strategies to boost the credibility of the research. A pilot study was carried out with a small representative sample consisting of 52 STEM workers. They were asked to take the online survey to ensure that it was error-free and clear. Furthermore, the survey responses were tabulated and used to ascertain validity, while reliability was checked by using Cronbach's alpha. Another source of bias that was addressed in this study was the rivalry between the various STEM fields. These rivalries can involve issues related to salaries, reputation, prestige, and respect, among others. These potential areas of conflict between the disciplines, professions, and job titles can result in significant biases that were addressed by using generic terminology and avoiding trade-specific lingo.

External validity addresses the generalizability of the sample data to a larger or different population. Care was exercised during the sampling period, to ensure that no sampling bias took place, so certain segments of the population were not better represented than others. Over one hundred professional STEM organizations were chosen for this study by identifying those organizations that had the larger and broadest membership base. This purposive sampling approach was pursued to obtain a sample that would replicate the actual demographic makeup and proportion of URMs in the STEM workforce, making the effort non-random. Another source of sampling error could come from not being able to select the true representative sample of the overall STEM industry population. The researcher wanted a good representation of the various disciplines and levels of responsibility within STEM. Thus, he recruited a highly heterogeneous sample, which included participants from various STEM backgrounds, levels of professional work, ethnicities, and socioeconomic backgrounds. Other threats to validity, such as the potential variability of the constructs among various subgroups surveyed, were also addressed. The researcher used a thorough review of the literature to find variables and constructs that are reported to hold across various population subgroups.

The open-ended questions included in the research instrument were analyzed using a grounded theory approach (Creswell & Poth, 2016). According to Creswell and other researchers, there are several ways to ensure the quality of a grounded theory approach. The study should (a) involve a process, an action, or an interaction (Career choice); (b) include a coding process which starts with the data and forms a larger theoretical model (Motivators, and factors, to personal stories); (c) illustrate the theoretical model in a figure/diagram (Decision matrix or flow chart); (d) include a storyline connecting categories in the theoretical model (Chronology of decision); (e) integrate "memos" throughout the research

(Documenting the coding categories derived from the responses and the analysis); and (f) include a reflexivity or self-disclosure by the researcher about his stance on the study.

Data Analysis

The data from the open-ended questions were compiled and analyzed by the researcher using a grounded theory approach. Grounded theory was chosen because it allows for a comprehensive picture of the professional journey of STEM professionals across various backgrounds to be illustrated. The recommendations of Maxwell (2012) about grounded theory using the processes of open, axial, and selective coding were applied. Inductive qualitative coding was used in the open coding phase to identify codes representing motivators and barriers. The researcher also looked for codes representing "bins" or specific categories of role models, instances of family influence, life-changing moments, expectations, environmental effects, and socioeconomic status details, among others. The careful examination of the responses to all of the questions would have allowed the researcher to identify a number of codes. However, minimal qualitative data was collected due to time constraints, so the coding of the data was not carried out. Instead, the researcher took the responses from the open-ended question and interpreted them as anecdotal independent statements, without any further analysis.

The data obtained from the multiple-choice and Likert scale questions used in the survey were analyzed using inferential statistics. Chi-squares were used to find the relationship between the participants' demographic variables such as ethnicity and variables such as motivators. The ethnicity was simplified into two categories for the purpose of this study: URM and non-URMs. Analysis of Variances (ANOVAs) was also carried out between selected variables such as Math ranking and the ethnicity of participants to examine if there was a statistically significant difference between URM and non-URM participants. The quantitative findings were combined with the qualitative analysis of open-ended questions, to create the story explaining the motivators and barriers experienced by students in pursuing careers in the STEM fields.

Ethical Concerns

It is important for ethical and legal requirements to be strictly followed to ensure complete transparency and confidentiality to protect the well-being and privacy of everyone involved, especially anyone or any group perceived as a "vulnerable population" (Lochmiller & Lester, 2016). All participants were fully informed of the purpose of the study, the types of questions that would be asked, any potential risks to them or others, the confidentiality of the process, as well as the voluntary nature of their involvement. The researcher made it clear that participants were free to opt-out at any time. A signed consent form (see Appendix C) was collected from each willing participant. Professionalism and the highest level of ethics were exhibited throughout the collection, coding, and analysis of the data. Upon completion of the study, and the publication of the results, the participants would be granted access to the research findings; therefore, the researcher included details about the future location and accessibility of the data in the survey/introductory email and letter of request to the participants.

Preliminary Pilot Findings

Following IRB approval (see Appendix D), the researcher conducted a preliminary pilot study of the research instrument. The online survey was sent to 15 people, including friends and family, who were for most of them, STEM practitioners. The participation in this pilot study was demographically consistent with the existing makeup of the STEM workforce. Questions were mostly clear and easily understood; however, some small corrections were made based on participants' feedback. Some of the feedback included suggestions such as having the ability to move forward to the next question even if a question was left blank. That suggestion was provided by a respondent that explained that the

SAT/ACT did not exist when she attended high school. Others did not have AP courses available, or some did not even attend college. This pilot helped the researcher refine the clarity and the timing of the questions. The survey took participants between 20 to 35 minutes to complete.

Researcher's Perspective

The researcher is a STEM practitioner. He believes in the importance of STEM. As a retired professional engineer turned high school engineering instructor, he repeatedly pointed out the struggles that students face while trying to excel in STEM courses and the difficulty of choosing a career after high school that they "would be good at." The researcher believes that the potential STEM employment crisis is real, and that students are graduating without the basic technical and soft employability skills that the fast-evolving STEM industry requires. He sees the problem to be especially significant for Underrepresented Minorities whose social network and support is composed of people like them; who have been ostracized, alienated, left out, ignored, or plainly discriminated out of the STEM workforce. He believes that underrepresented minorities' surrounding thus has little to offer in the form of advice and have less influence in directing them towards a STEM field.

Summary

The current study used a mixed method methodology. The participants were recruited using stratified purposive sampling from 100 STEM companies. They came from various STEM backgrounds, levels of professional work, ethnicities, and socioeconomic status. The research instrument was constructed by the researcher based on the variables identified from the literature review and the two theoretical frameworks used in this study, the expectancy-value theory and the social cognitive theory. The online survey was made up of open-ended and closed-ended questions. It focused on five main constructs: self-efficacy, subjective task value, utility value, expected cost, environmental influences, and social interactions that led each of the participants to choose their careers. Several measures were put in place to ensure validity and reliability, such as using a comprehensive review of the literature to design the survey, piloting the resulting research instrument, clarifying researcher bias, and using a large heterogeneous sample of participants. The quantitative data collected was then analyzed using inferential statistics such as chi-squares and ANOVAs. In contrast, the responses to the open-ended questions were analyzed using a grounded theory approach. All ethical requirements recommended by the IRB, such as confidentiality were maintained.

CHAPTER 4: RESULTS

The primary goal of the study was to identify the most influential variables that impacted the decision of Underrepresented Minorities (URMs) to pursue a STEM career so that programs and resources could be identified, and funds properly channeled to ensure that relevant areas are addressed. The main research question that was covered in this study was: What are some of the strategies needed to encourage, motivate, and support underrepresented minorities into STEM careers? The most influential motivation factors that impacted these decisions were subsequently identified.

The Institutional Review Board (IRB) approval to proceed was granted on March 14, 2019. The online survey instrument was sent to over 100 professional STEM organizations, as well as several independent groups comprised of STEM and Non-STEM members. Overall, the survey was attempted by 382 individuals, with 318 completing it and submitting it, yielding a response ratio of 83.5%. The idea of surveying Non-STEM participants was based on the concept of creating a control group for data analysis and validation. The purposive survey, which was made up of 43 questions, was opened and sent out on March 27, 2019, and it closed on August 15, 2019. A copy of the survey and the introductory letter are shown in Appendices A and B, respectively.

In this chapter, the researcher presents the data as it was collected and analyzed using descriptive and inferential statistics. This chapter also includes the results of the analyses. Although a multitude of data was collected about 120 possible motivating factors ranging from demographics to respondents' various academic and professional experiences. The current study focused on the identification of the most critical factors that ultimately impacted respondents' decision to pursue a career in STEM or not. The potential relationship of being underrepresented and non-underrepresented minorities to the significant variables was also assessed to narrow down the most influential factors that led respondents to their decisions.

Initially, a Pearson linear correlation analysis was performed on the complete dataset collected from the online survey, including both URMs and Non-URMs. The purpose of this initial analysis of all the participants (n = 318), regardless of whether they were URMs or Non-URMs, was to identify the variables that impacted the respondents' decision to pursue a career in STEM. This analysis created a control group.

All 120 variables were considered as independent variables affecting the respondents' decision to pursue a STEM career, which was the dependent variable. Those independent variables found to have a p value less than .05 were considered to be significant, and the strength of the relationship between the concerned variables was determined from the correlation coefficient (r). The strength of the correlations was categorized as weak (0.00 – 0.19), moderate (0.20 – 0.45), and strong (0.46 – 1.00). The direction of the correlation, positive or negative, indicated whether the relationship was proportional or inversely proportional.

A chi-square analysis was also performed, which allowed the strength of the relationships between ethnic groups (URMs and non-URMs) and demographic variables to be examined. The researcher looked for the strength of the relationship by considering the correlation coefficients and identifying the most significant of those demographic characteristics in the sample population surveyed.

Analyses of Variance (ANOVAs) of each of the variables identified as statistically significant by the linear correlation analyses were undertaken; the ethnicity (URM *v*. Non-URM) was assigned as the independent variable. The researcher investigated whether the difference in the variables by ethnicity was statistically significant.

A second and similar Pearson's correlation analysis was also run, this time on the data from URMs only (n = 62) to identify the significant factors that influenced this particular group of respondents' decision to go into STEM. This analysis used the professional field

(STEM *v*. Non-STEM) as the dependent variable while holding the 120 factors as the independent variables. An Analysis of Variances (ANOVA) of these variables between the STEM and Non-STEM participants within the URM group was also performed to narrow down to the strongest influencers and motivators impacting the career decision of URMs. A comparison of the significant motivation factors impacting the total sample population (URMs and Non-URMs) and the factors only impacting the URMs would be used to identify the most influential factors.

Demographics

Over 100 STEM professional organizations and groups were sent the online survey asking them to distribute to their membership. Although there was an expectation of receiving an average of somewhere between 8 to 10 responses per professional organization, for a total of 800 to 1000 responses, the response rate was below expectations. The underrepresented minorities were underrepresented in the pool of responses received, exemplifying and underscoring the issue of underrepresentation of Blacks and Hispanics in STEM. This survey was a joint data collection effort undertaken by two doctoral co-researchers to collect data on potential STEM career motivators for underrepresented minorities and for women. The doctoral students shared their data. The results of the survey and performed various types of analyses to identify potential motivators and influences that have increased the participation of underrepresented minorities and women in STEM careers.

Most respondents were White/Caucasian (63%), with Asians (17%) coming a distant second, followed by Hispanics/Latinos (16%), Black/African Americans (3%), and a very small response by Pacific Islanders and Native Americans. However, sadly, these numbers closely mirrored the actual make-up of the STEM workforce in the United States and reflected the underrepresentation that this study is aiming to reduce. There were 165 females (52%) and 152 males (48%), with 142 (49.5%) of them being STEM practitioners, and 145

(50.5%) working in non-STEM fields. The sample population was comprised of 199 White/Caucasian (63%), 54 Asians (17%), 52 Hispanic/Latino (16%), and 10 Black/African American (3%). The number of Underrepresented Minorities (URMs) in that population was 62 (19.7%), while Non-Underrepresented Minorities totaled 253 (80.3%).

The age-related data was broken down into five distinct categories. The smallest numbers of participants belonged to the age group in the lower category; 27 (9%) respondents were aged 19 to 25. Participants ranging in age from 26 to 35 totaled 73 (23%). Participants aged between 36 to 45 years old totaled 63 (20%), while those between 45 to 55 totaled 55 (18%). The greatest number of respondents were older than 55, summing up to 95 (30%) people. The marital status of the respondents varied with a large majority of respondents, 225 (72%), being married. Only 69 (22%) of respondents were single while 5% were divorced and 1% was widowed. The numbers of children that respondents had ranged from zero to five or more. There were 113 (35%) of them with no children, 133 (41%) with 1 to 2 children, 64 (20%) with 3 to 4, and 8 (3%) with five or more.

The annual income data was broken down into five categories. There were 23 (10%) respondents making less than $29,999. The number of respondents earning in the middle-income categories was quite similar: 68 (23%) respondents had salaries in the range of $30,000 to $69,999, 59 (22%) in the range of $70,000 to $99,999, and 68 (23%) in the $100,000 to $149,999. There were fewer participants earning in the higher income categories: 36 (13%) reported incomes in the range of $150,000 to $199,000, and 24 (9%) reported making over $200,000 per year.

The data depicting the highest educational level of the respondents, as well as the highest educational level of both of their parents, were also collected and analyzed. There were 18 (6%) respondents who reported being high school graduates. There was a group of 26 (8%) that achieved an associate degree, 6 (2%) of them attained a technical or vocational certificate, while 125 (39%) received a bachelor's degree. The majority of participants were highly qualified with postgraduate degrees. Among the highly qualified pool of respondents, 107 (34%) had masters' degrees, and 37 (12%) had doctorates.

The parental education data revealed that 14 (4%) fathers and 18 (6%) mothers had completed elementary school. Junior high school was completed by 18 (6%) fathers and 19 (6%) mothers. Ninety-one (29%) fathers, and 76 (24%) mothers. There were 52 (16%) fathers and 38 (12%) mothers with master's degrees. At the doctoral level, there were 27 fathers (8%) and 10 (3%) mothers.

Table 1

Demographic Data of Participants

Demographic Category	Count	Percentage
Gender (*n* = 317)		
Male	165	52%
Female	152	48%
Ethnicity (*n* = 315)		
White	199	63%
Asian	54	17%
Hispanic	52	16%
Black	10	3%
URM/Non-URM (*n* = 315)		
URM	62	20%
Non-URM	253	80%
Age (*n* = 314)		
19-25	27	9%
26-35	73	23%
36-45	63	20%
46-55	55	18%
56+	95	30%
Marital Status (*n* = 315)		
Single	69	22%
Married	225	72%
Divorced	16	5%
Widow	4	1%
Number of Child (*n* = 315)		
None	113	35%
1 to 2	133	41%

3 to 4	64	20%
5+	8	3%
Income (n=278)		
Under $29K	23	10%
$30K - $69K	68	23%
$70K - $100K	59	22%
$100K-$149K	68	23%
$150K-$200K	36	13%
Over $200K	24	9%
Education (*n* = 318)		
Elementary Only	0	0%
Middle School Only	0	0%
High School Grad	18	6%
Technical/Vocational/Associate	32	10%
Bachelors	125	39%
Masters	107	34%
Doctorate	37	12%
Father Education (*n* = 317)		
Elementary Only	14	4%
Middle School Only	18	6%
High School Grad	77	24%
Tech/Vocational/Associate	39	12%
Bachelors	91	29%
Masters	51	16%
Doctorate	27	8%
Mother Education (*n* = 316)		
Elementary Only	18	6%
Middle School Only	19	6%
High School Grad	101	32%
Tech/Vocational/Associate	55	17%
Bachelors	76	24%
Masters	37	12%
Doctorate	10	3%

Quantitative Data Analysis

Firstly, an initial quantitative analysis of the data, using a chi-square was performed on the demographic responses by the ethnicity breakdown of URMs and Non-URMs. This analysis focused on finding whether the relationships were significant and could thus potentially impact the determination of the most influential factors in respondents' decisions to pursue STEM careers. Secondly, the study aimed at examining the linear relationship between all the variables identified by the survey. The level of significance of the inter-correlations of these potential independent variables was determined using a Pearson's linear correlation analysis.

The primary goal of the analysis was to determine if the values within each category rose to the desired level of significance, where the *p* value is lower than .05. The strength of the relationship was measured by Pearson's correlation coefficient (*r*), where 0 shows no relationship, +1 a very strong positive relationship, and -1 a very strong negative relationship. A positive relationship means that as one variable changes, the other variables also change in the same direction. A negative relationship implies that the changes happen in opposite directions. The closer the correlation coefficient, *r*, is to the absolute value of 1, the stronger the correlation is between the two variables. The variables were then classified based on the strength of their correlations coefficients (*r*), and were broken down into three groups, weak (absolute value = .0 to .19), moderate (absolute value = .20 to .45) and strong (absolute value = .46 to 1.0). The analysis was run for each variable against the STEM *v* Non-STEM data. Only those variables that were found to be significant were then analyzed against the ethnicity of the population. Ethnicity was originally categorized as Asian, Black/African American, Hispanic/Latino, White/Caucasian (Non-Hispanic), and Other, however, it was later coded into two distinct groups Underrepresented Minorities (Black/African American and Hispanic/Latino), and Non-Underrepresented Minorities (Asian, White/Caucasian, and Other).

Chi-Square Tabulations for Demographic data

The purpose of the analysis was to test each of the demographic variables (nominal/categorical) against the ethnicity related variables, URM *v* Non-URM to see if those variables were independent of each other, or there was any potential relationship. The sets of variables for which the null hypothesis is rejected cannot rule out that the variables may depend on each other. The null hypothesis for this test is that there is no relationship between the two categorical variables and that they are independent.

The chi-square test is designed to see if there is a significant relationship between two nominal or categorical variables. It measures how well the observed distribution of data fits with the expected distribution (Math is fun, n.d.). If the null hypothesis is rejected, then it means that there is not enough information to assume that they are independent of each other. When the p value < .05, the null hypothesis cannot be accepted, and therefore it is rejected. All categorical demographic variables, including gender, marital status, ethnicity, number of children, education, father's education, and mother's education were used in the analyses. Age and income were not tested because they had interval data, and chi-squares only apply to categorical data.

After running the chi-square test on all the categorical demographic variables, only 3 of them were found to be statistically significant with a p value < .05. Therefore, they were not ruled out as independent of each other. Those two variables were the father's education and mother's education. After further analysis and comparison of the data, using chi-square analysis of the average of the means, there were no distinct patterns or relationships shown. However, the small size of the sample may have influenced those results. These variables were thus not taken into account in the current study. Only two demographic variables seemed to have some type of relationship to ethnicity. They were: Mother's education and father's education.

These findings, although inconclusive, reinforce the concept that these two demographic factors are important to students' career decisions, particularly in choosing a STEM field or not. From this analysis, it could be noted that the level of effective parental influence is highly influenced by the level of education that their parents had attained. Educated parents may have experienced a level of STEM career influence or exposure to which less-educated parents may not have been exposed. Unfortunately, there seems to be no observable pattern on how the levels of parental education affect that decision.

Full Sample Population Analysis (URMs and Non-URMs)

The description of STEM *v* Non-STEM was established by the researcher based on the Standard Occupational Classification (SOC) codes from the U.S. Bureau of Labor Statistics published in 2018. The researcher identified and segregated the careers that were related to STEM (math/science), and those that were not related to any of the STEM fields (Bureau of Labor Statistics, 2018). These chosen careers excluded business professionals in the fields of accounting, construction, law, and health sciences. However, the chosen careers ranged from entry-level positions all the way up to the management of STEM resources.

There were 287 respondents that reported whether they were STEM practitioners or not. From the total, the numbers of respondents in STEM and Non-STEM fields were very close (see Figure 1).

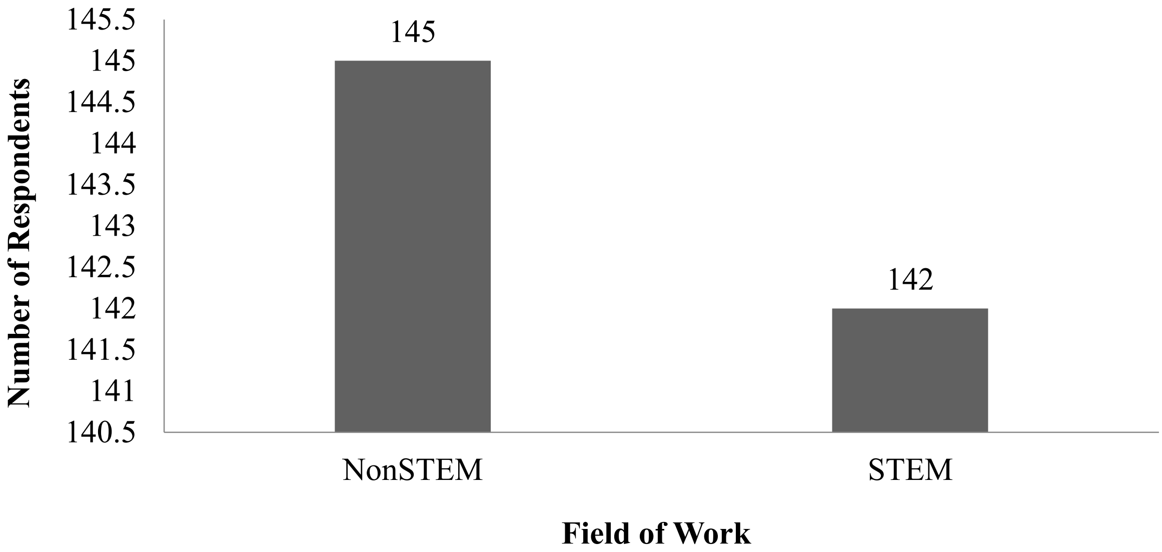

Figure 1. STEM *v*. Non-STEM.

Testing All Factors Against STEM *v.* Non-STEM for URMs and Non-URMs

Using StatPlus and Excel, all the variables, the potential influencing factors, were analyzed using Pearson's linear correlations with the decision of participants to pursue a career (n = 318) in STEM (expected outcome/effect). The following variables were found to have a p value less than .05, and therefore their relationship considered to be statistically significant. There were 20 variables identified as significant, and the strength of their influence varied from strong to low.

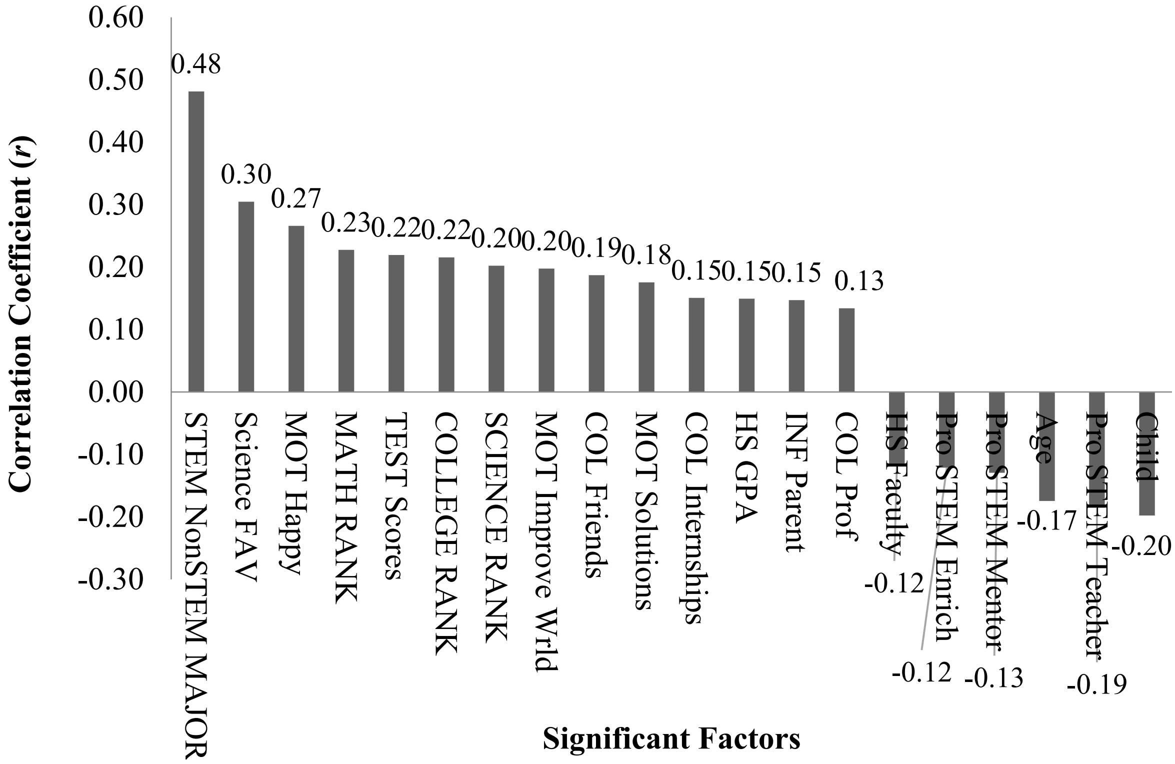

Figure 2. Linear correlation analysis URMs and Non-URMs.

The strength of the relationship between these variables is reflected by the correlation coefficient (r). Table 2 ranked the variables based on the strength of the coefficients. Variables with an absolute value of r ranging from .0 to .19 were considered weak relationships, while those with values of .20 to .45 were considered moderate, and those with values of .46 to 1.0 were considered strong correlations. Based on these assumptions and findings, only one of the variables was considered to have a strong relationship with the decision to pursue a STEM career. The variable was: Having the choice to choose a career. There were seven variables with a moderate positive correlation with the decision to pursue a

STEM career. They were: Science being their favorite subject in high school (HS), being motivated by personal satisfaction/happiness, HS math being ranked, undergraduate college attended being ranked, SAT/ACT test scores, HS science being ranked, and motivated by improving the world. There was a moderate negative correlation between choosing a STEM career and the number of children the respondents had. The more children they had, the less likely they were to choose a STEM career. All other 11 variables had a weak correlation, of which five had an inverse relationship to the decision to pursue STEM careers, while the others had a direct proportional influence. Those variables that exhibited weak correlations with STEM career decisions also had negative relationships with the STEM career decision. They were HS faculty influence, STEM enrichment program, STEM mentor influence, age, and STEM teacher influence.

A Pearson's linear correlation analysis: STEM *v* Non-STEM was performed on the 120 variables for all participants, URMs, and Non-URMs (see Table 2).

Table 2

Correlation Analysis Showing Significant Variables

Factor	*p* value	*r*	Strength
Demographics			
Age	0.00304	-0.17	Weak
# of Children	0.00075	-0.2	Moderate
Parental	0.01489	0.15	Weak
Motivators			
Happiness	6.9E-05	0.27	Moderate
Improving World	0.00094	0.2	Moderate
Finding Solutions	0.00337	0.18	Weak
HS Experience			
Math Ranked	0.0001	0.23	Moderate
Science Ranked	0.00057	0.2	Moderate
Science Favorite	2E-07	0.3	Strong
HS Faculty	0.04872	-0.12	Weak
HS GPA	0.01438	0.15	Weak
Test Results	0.00533	0.22	Moderate
College Experience			
College Ranked	0.0005	0.22	Moderate

Research/Internship	0.01188	0.15	Weak
College Friends	0.00187	0.19	Weak
College Professor	0.02635	0.13	Weak
Pro STEM Influences			
STEM Enrichment Program	0.0424	-0.12	Weak
STEM Teacher	0.00186	-0.19	Weak
STEM Mentor	0.02977	-0.13	Weak

The 20 variables that were found to have a significant association with the decision of the participants to pursue a STEM career or not, and their corresponding survey questions are shown in the next section. The question number is shown in parentheses. The survey questions were categorized into five groups. There were different numbers of survey questions in each group.

Demographics:

1. What's your age? (4)
2. How many children do you have? (6)

Influence:

3. To what extent would you agree your parents influenced you to pursue a career in STEM? (11)
4. To what extent would you agree that personal satisfaction/happiness was the primary reason you pursued a career in STEM? (12)
5. To what extent would you agree that wanting to make the world a better place following was the primary reason you pursued a career in STEM? (12)
6. To what extent would you agree that liking to find solution to problems was the primary reason you pursued a career in STEM? (12)

High school experience:

7. Math ranked as rigorous. (19)
8. Science ranked as rigorous (19)

9. Science as a favorite subject. (20)
10. Influenced by HS faculty. (26)
11. HS GPA (27)
12. SAT/ACT Test scores (28)
13. Ranking of undergraduate college attended (29)

College experience:

14. Pursued a STEM or a Non-STEM major. (30)
15. Access to internships and research opportunities. (32)
16. Influenced by college friends/peers. (33)
17. Influenced by college professor. (33)

Employment experience:

18. Professional Career influenced by STEM Enrichment Program. (39)
19. Professional Career influenced by HS Teacher. (39)
20. Professional Career influenced by Role Model/Mentor. (39)

The researcher ranked each variable in decreasing order of correlation strength and on the direction of the correlation, that is, whether the correlation results were directly (positive) or inversely (negative) proportional to the influencing factor (see Table 2).

The resulting correlations were divided into three distinct groups; strong correlation (.46 to 1.0), moderate correlation (.20 to .45), and weak correlation (0 to .19). Based on these delimitations, the researcher found a positive strong correlation of .48 for the variable related to a choice of STEM or Not STEM. No negative strong correlations were revealed by this analysis. There were seven positive moderate correlations for motivated by improving the world ($r = .20$), the ranking of the high school science program ($r = .20$), the ranking of the undergraduate college attended ($r = .22$), the SAT/ACT scores ($r = .22$), the ranking of the high school math program ($r = 0.23$), motivated by personal satisfaction and happiness (r

= .27), and science being a favorite subject (*r* = .30). A negative moderate correlation was found between the number of children (*r* = -.20) and STEM career decision. Weak positive correlations were found with the influence of college professors (*r* = .13), parental influence (*r* = .15), high school GPA (*r* = .15), participation in a college internship (*r* = .15), motivated by finding solutions to problems (*r* = .18), college friends (*r* = .19). Negative weak correlations were found with influence by high school faculty (*r* = -.12), participation in a STEM enrichment program (*r* = -.12), STEM mentor (*r* = -.13), age (*r* = -.17), and STEM teacher (*r* = -.19).

Analysis of Variances (ANOVA) for URMs and Non-URMs (*n* = 318)

These 20 significant variables identified through the Pearson's linear correlation analysis were then assigned as the dependent variables (DV) and analyzed using StatPlus through analysis of variances (ANOVAs) against the independent variable (ID) of ethnicity. Ethnicity was simplified by breaking it down into two distinct categories: Underrepresented Minorities (URMs) and Non-Underrepresented Minorities (Non-URMs). The purpose of this test was to determine whether the differences in the variables between the group means were statistically significant. A significance level (alpha) of .05 denotes that there is a 5% risk of concluding that a difference exists when there is no actual difference. If the *p* value is less than or equal to the significance level, alpha, the null hypothesis is rejected, and it is concluded that not all population means are equal. If the *p* value is greater than the significance level, then there is not enough evidence to reject the null hypothesis that the population means are all equal.

The ANOVA analysis is premised on the assumption that the data are sampled from populations that all have the same standard deviations. The *p* value tests the null hypothesis that data from all groups are drawn from populations with identical means. If the overall *p* value is large, the data does not give any reason to conclude that the means differ. There is not enough compelling evidence to say that they differ. If the *p* value is small, then it is unlikely that the observed differences are due to random sampling.

Variability (*df*) among the group means is quantified as the sum of the squares of the differences between the group means and the grand mean. Variability (*df*) within the group means is quantified as the sum of the squares of the differences between each value and its group mean. The *F* ratio is the ratio of two mean square values. If the null hypothesis is true, *F* should be close to 1. A large *F* ratio means that the variation among group means is more than was expected to occur by chance.

The following results show the Analysis of Variance (ANOVA) performed on each of the 20 critical variables (as independent variables) identified by the Pearson linear correlation analysis, against the dependent variable of ethnicity, which for this study was re-defined as Underrepresented Minorities v. Non-Underrepresented Minorities (see Table 3).

Table 3

Analysis of Variances (ANOVA) on Variables by URM

Factor	*p* value	*n*	*F*	URM *v*. Non-URM
Demographics				
Age	0.0195	307	5.5	Non-URM
HS experience				
Maths ranked	0.0001	311	9.48	URM
HS faculty	0.0487	292	7.23	Non-URM
College experience				
College professor	0.0107	271	6.62	Non-URM
Pro-STEM influence				
STEM enrichment	0.0041	269	8.39	Non-URM

This analysis yielded only five significant variables (from the 20 significant variables identified earlier), which were impacted by the ethnicity breakdown (URM or Non-URM) of the sample population. These highly significant dependent variables were: Math ranking of the high school, the influence of college professors, the influence of the high school faculty, participation in a STEM enrichment program, and the age of the candidate.

These significant variables were found to influence the career decision of both URMs and Non-URMs, however, based on the mean value of the responses given, some were more influential among URMs than they were to Non-URMs (see Figures 3 to 7).

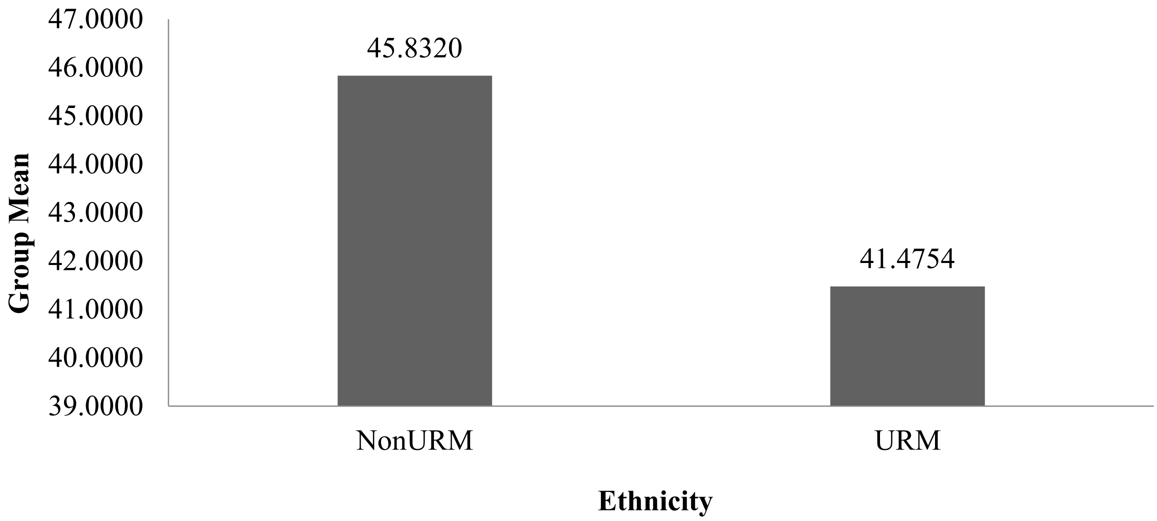

Figure 3. Mean age of respondents by ethnicity.

The mean age of the candidates seems to be slightly higher for Non-URMs (45.8) participants than what it was for URM participants (41.5).

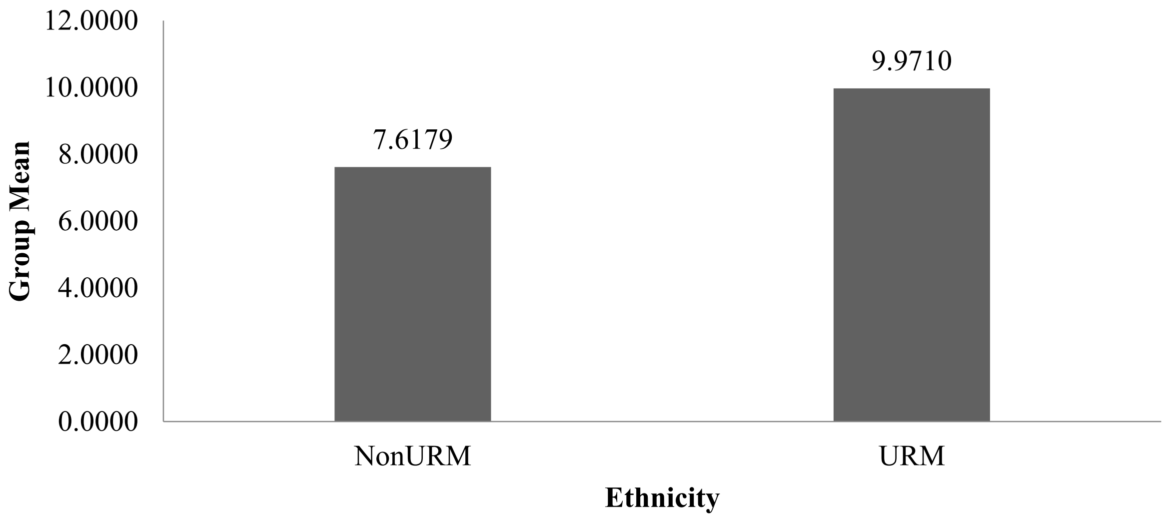

Figure 4. Math ranking in HS.

The mean “Math ranking of the HS” of the URM respondents (9.97) seems to be higher (30.9%) than the same variable for Non-URMs (7.76).

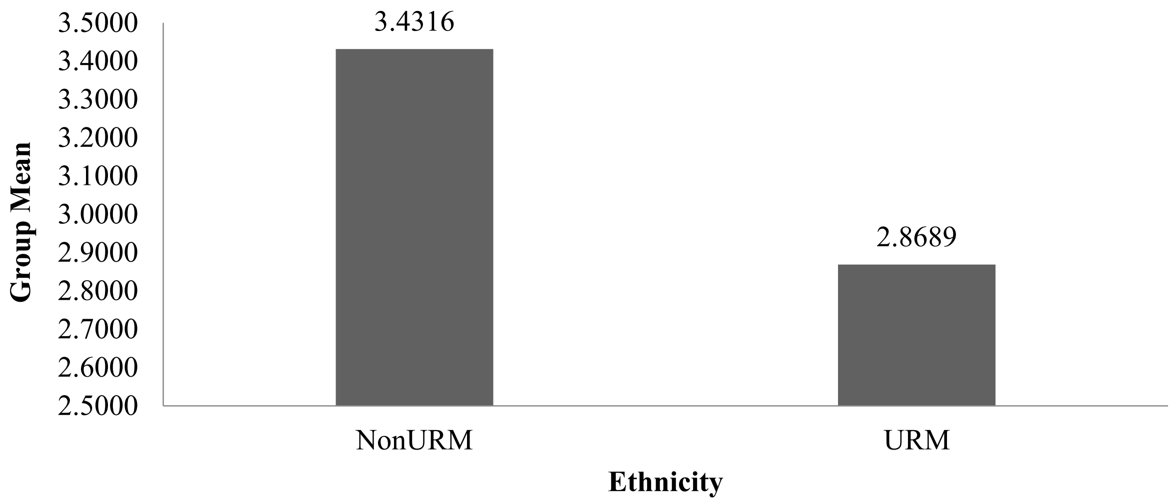

Figure 5. Influence of HS faculty.

The mean response value for the variable, the influence of HS faculty, of the Non-URM respondents (19.6%) was 3.4316, which was higher than for URMs (2.8689).

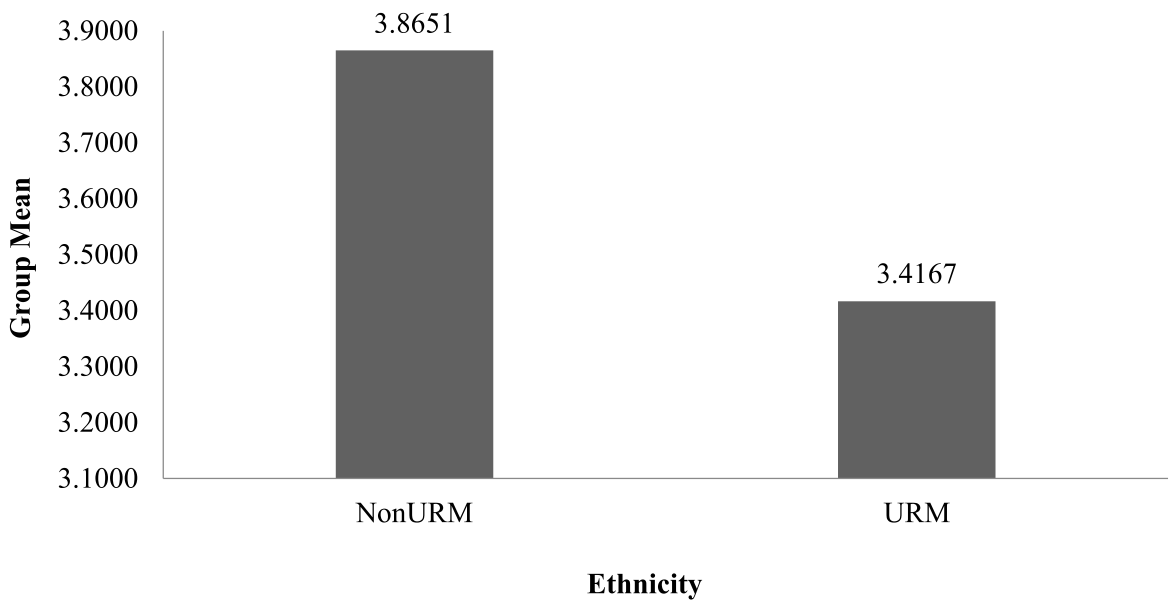

Figure 6. Influence of college professor who looked like me.

The mean response value for “influence of college professor” of the Non-URM respondents (3.86) seems to be higher (13.1%) than the same variable for URMs (3.41).

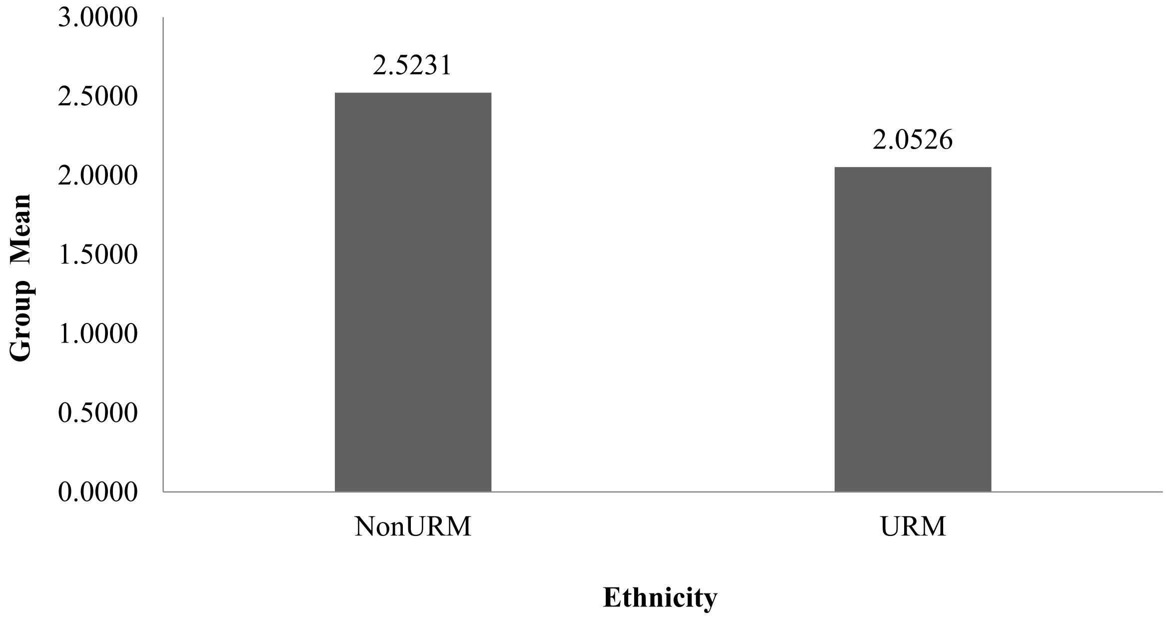

Figure 7. Participation in STEM enrichment program

The mean response value for the variable, participation in STEM enrichment program, of the Non-URM respondents (22.9%) was 2.5231than for URMs (2.0526).

URM Sample Population Analysis

The description of Underrepresented Minorities (URMs) *v* Non-Underrepresented Minorities (Non-URMs) was based on the literature review of existing ethnic representation in the various fields of STEM. Three groups were identified to be underrepresented as compared to their proportional demographic make-up in the overall general population in the United States. Those underrepresented groups were Blacks/African Americans, Hispanics/Latinos, and Pacific Islanders, while White/Caucasians and Asians were overrepresented.

For ease of analysis, the researcher broke the ethnicity data into two distinct groups Underrepresented Minorities (Blacks and Latinos) as URMs and Non-Underrepresented Minorities (Whites and Asians) as Non-URMs. Based on 315 responses, the sample population was composed of 62 URMs (19.7%) and 253 Non-URMs (80.3%), as shown in Figure 8.

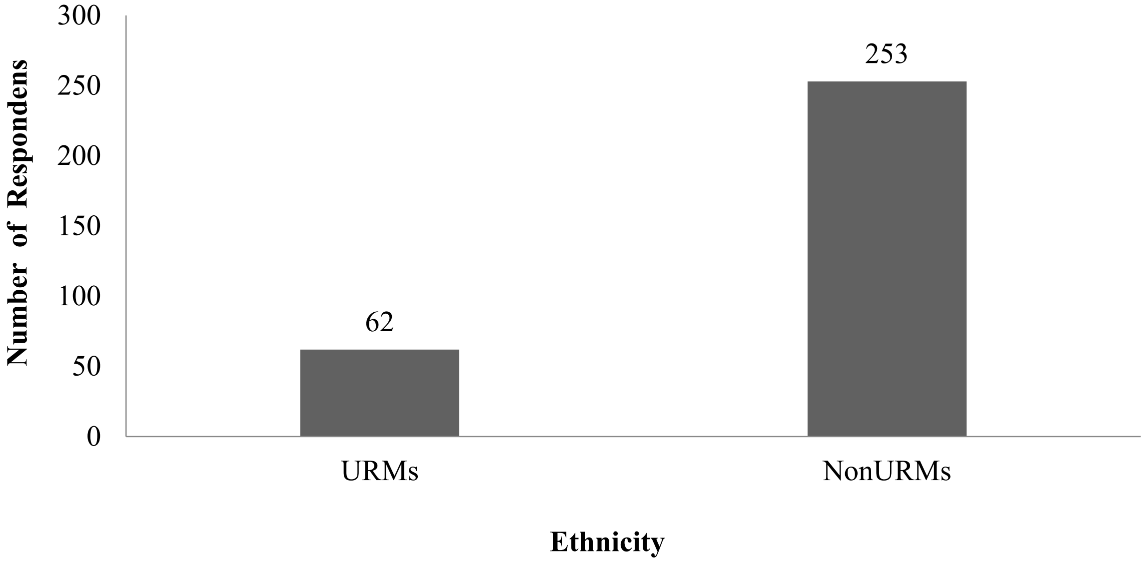

Figure 8. URMs *v* Non-URMs.

Correlation Analysis for URMs (*n* = 62)

The Pearson correlation analysis yielded 11 significant variables with various degrees of strength and having positive, as well as negative impacts. Those positive variables which mostly influenced the URMs decisions to go into STEM, as compared to not going into STEM were: No STEM like you (Seeing no person like them in STEM) No STEM ability (Being told that he/she did not have the ability to go into STEM), and College family (Family support during college). The negative variables which had a larger influence on persuading URMs to go into Non-STEM fields, as opposed to going into STEM fields were: college friends, pro STEM parents, parental influence, Pro STEM parent, pro STEM education, college faculty, pro STEM friend, and pro STEM enrichment program (see Figure 9).

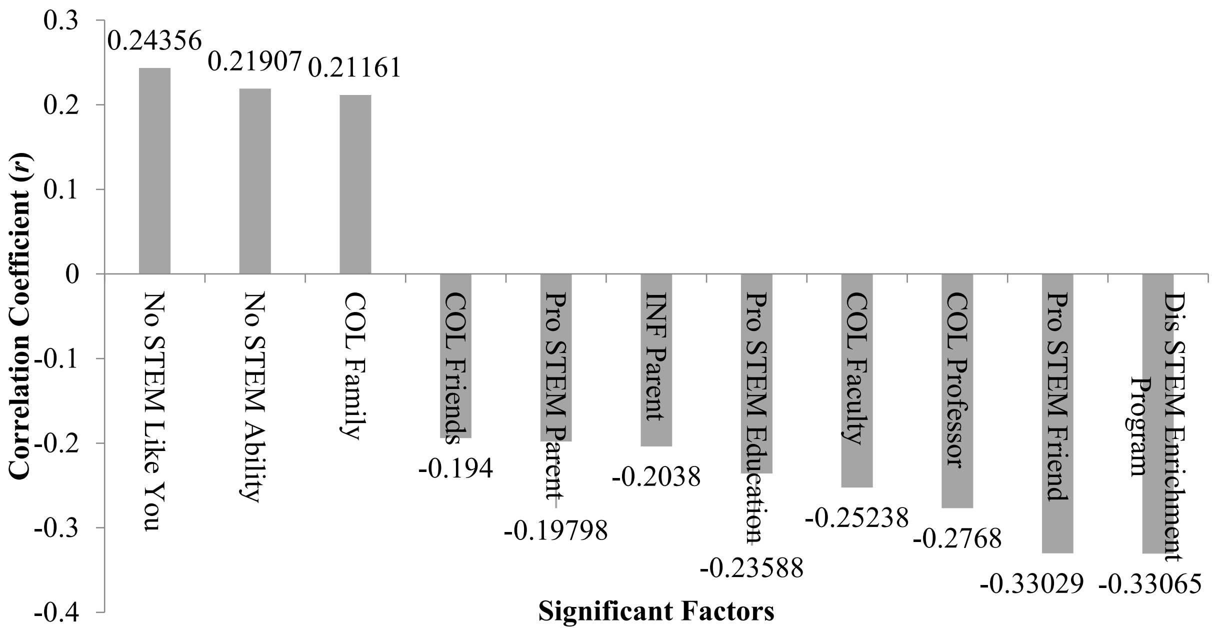

Figure 9. Correlation analysis for URMs only (n = 62).

A listing of all the 11 significant variables obtained by Pearson's correlation analysis can be found in Table 4. The correlation coefficient (r), as well as the direction and strength of the correlation, are also shown in that table.

Table 4

Inter-correlations between Significant Variables for URMs

Factor	*p* value	*r*	Strength
Demographics			
Parental	0.0344	-0.2	Moderate
Dissuaders			
STEM enrichment program	0.0005	-0.33	Strong
College experience			
College faculty	0.0084	-0.25	Moderate
College family	0.0442	-0.19	Weak
College friends	0.0279	0.21	Moderate
College professor	0.0037	-0.28	Moderate
Pro STEM influences			
STEM education	0.014	-0.24	Moderate
STEM parent	0.0400	-0.2	Moderate
STEM friend	0.00048	-0.33	Strong
No STEM influences			
No STEM like you	0.01108	0.24	Moderate
No STEM ability	0.02273	0.22	Moderate

Analysis of Variance (ANOVA) for URMs Only (*n* = 62)

A set of Analyses of Variances (ANOVAs) of the URM sample population (*n* = 62) was carried out with the independent variable as the decision to pursue STEM *v* Non-STEM careers and the dependent variable as one of the factors examined in this study. This analysis revealed eight significant variables with *p* value < .05. Those variables were: Motivated by finding solutions to problems, motivated by happiness, HS environment, science as a favorite subject, college professor, and college internship. Gender (*p* value = .0506) and math as a favorite subject (*p* value = .05259) approached statistical significance; the *p* value exceeded the .05 threshold slightly; however, it is believed that if the URM representation in the sample population would have been larger, those two factors would have reached a level of significance (see Table 5).

Table 5

Analysis of Variances on URM Dataset (n = 62) for Variables by STEM Career Decision

Factor	*p* value	*r*	Strength
Demographics			
Age	0.00304	-0.17	Weak
# of Children	0.00075	-0.2	Moderate
Parental	0.01489	0.15	Weak
Motivators			
Happiness	6.9E-05	0.27	Moderate
Improving World	0.00094	0.2	Moderate
Finding Solutions	0.00337	0.18	Weak
HS Experience			
Math Ranked	0.0001	0.23	Moderate
Science Ranked	0.00057	0.2	Moderate
Science Favorite	2E-07	0.3	Strong
HS Faculty	0.04872	-0.12	Weak
HS GPA	0.01438	0.15	Weak
Test Results	0.00533	0.22	Moderate
College Experience			
College Ranked	0.0005	0.22	Moderate
Research/Internship	0.01188	0.15	Weak
College Friends	0.00187	0.19	Weak
College Professor	0.02635	0.13	Weak

Pro STEM Influences			
STEM Enrichment Program	0.0424	-0.12	Weak
STEM Teacher	0.00186	-0.19	Weak
STEM Mentor	0.02977	-0.13	Weak

*p value almost at the significance threshold of $p < .05$.

In this analysis, the researcher compared the means of each of the groups, STEM and Non-STEM participants on the influencing variables, and determined whether the difference between the means was statistically significant. It, therefore, established whether these variables had a significantly different impact on URMs and Non-URMs.

Figures 10 to 17 illustrate the various charts depicting the difference in means for STEM and Non-STEM groups as they relate to each of those significant variables. Two of the variables, gender, and math as a favorite subject, did not have a p value of $< .05$, however, approached statistical significance. It is possible that if the sample populations of URMs (n = 62) were larger, those two variables would have become significant.

By comparing the mean for each of the two groups, STEM and Non-STEM, on the influencing variables for the population of URMs, we can see how different their impact was for the URMs who chose STEM and those who did not. For example, college professors, college internships, science as a favorite subject, motivated by finding solutions, motivated by happiness, and math as a favorite subject had a larger impact on the career decision of STEM practitioners than they had on the career decision of Non-STEM practitioners. HS environment and gender had a larger impact on Non-STEM than on STEM practitioners. When the p value was found to be $<.05$, then the difference between the means was significant, and therefore a relationship or association of dependency was assumed. A more detailed analysis of the six significant variables (and two almost significant variables) found by the ANOVA analysis of the URM sample are presented in Figures 10 to 17.

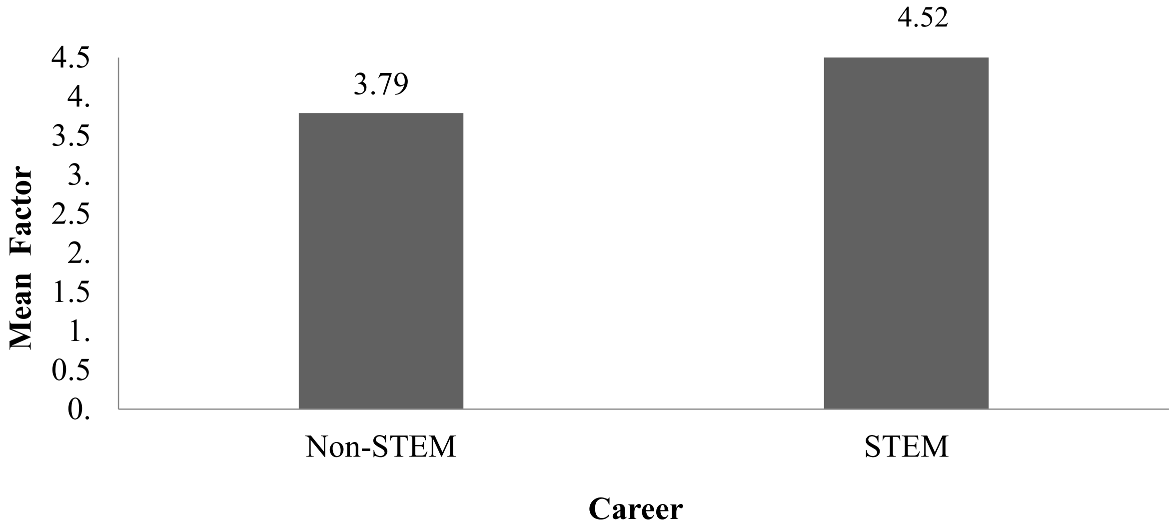

Figure 10. Means of factor, motivated by happiness, by career.

The means of the factor, motivated by happiness, is different when comparing STEM and Non-STEM groups within the URMs subsample. The STEM participants deemed this variable more influential in their career decision than their Non-STEM counterparts (see Figure 11).

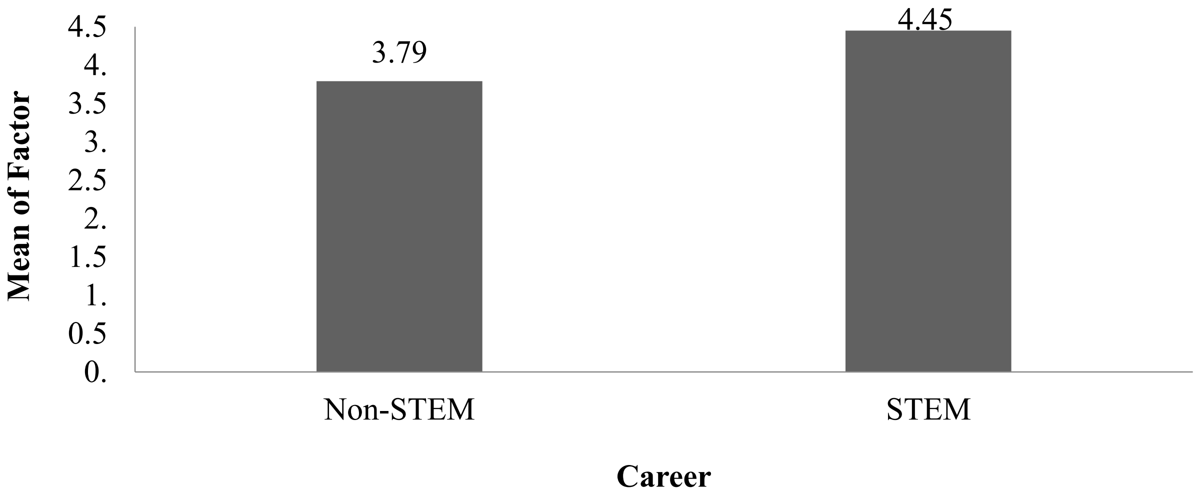

Figure 11. Means of factor, motivated by finding solutions to problems, by career.

Another factor that appears to have a slight difference (17%) of means between STEM and Non-STEM respondents in the URM subsample is being motivated by finding solutions to problems. In this case, the STEM participants seemed to be more motivated by this factor than the Non-STEM participants (see Figure 12).

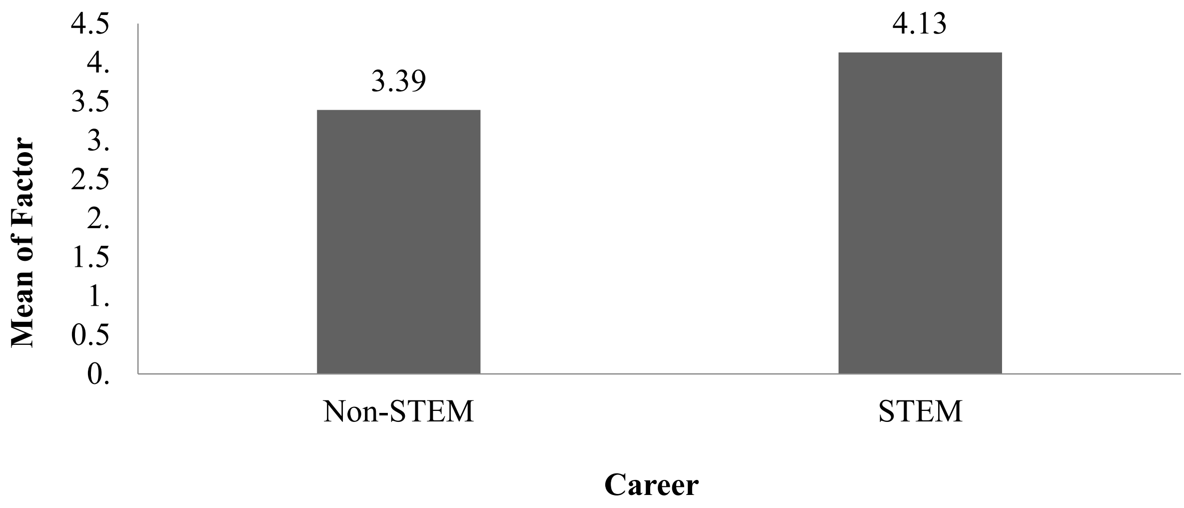

Figure 12. Means of factor, science as a favorite subject, by career.

Science as a favorite high school subject had a strong relationship with career decisions, with a significant difference between the means of STEM and Non-STEM (22%) participants. The influence, however, appeared to be higher for STEM, than for Non-STEM participants (see Figure 13).

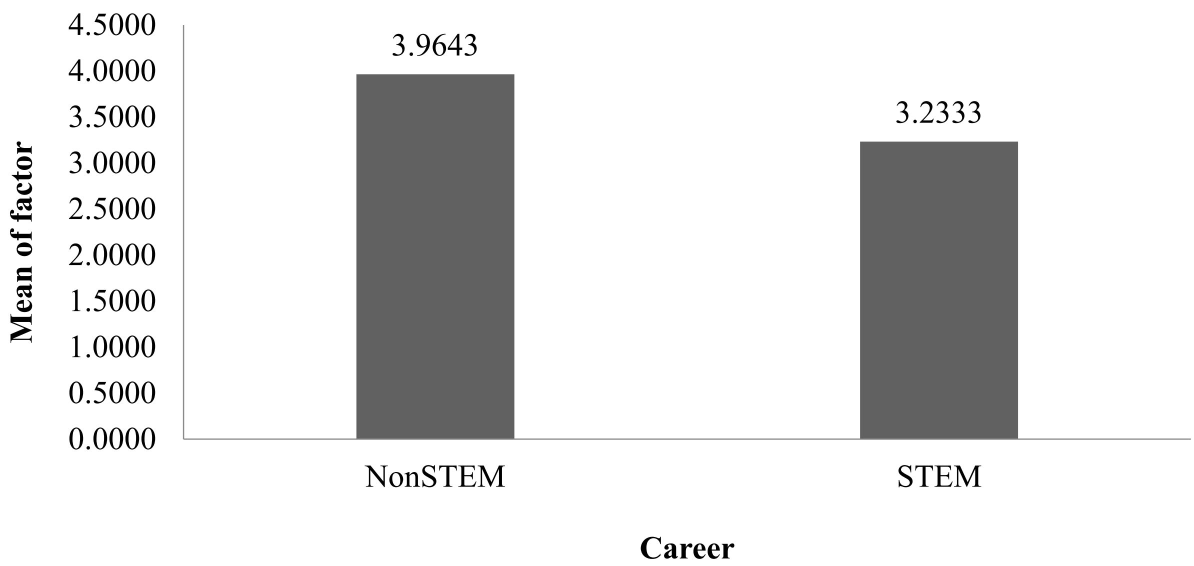

Figure 13. HS environment.

There was a significant difference in the factor, HS environment, on the decision of the participants to choose STEM or Non-STEM careers (23%). Non-STEM participants seemed to be more influenced by the HS environment than their STEM counterparts (see Figure 14).

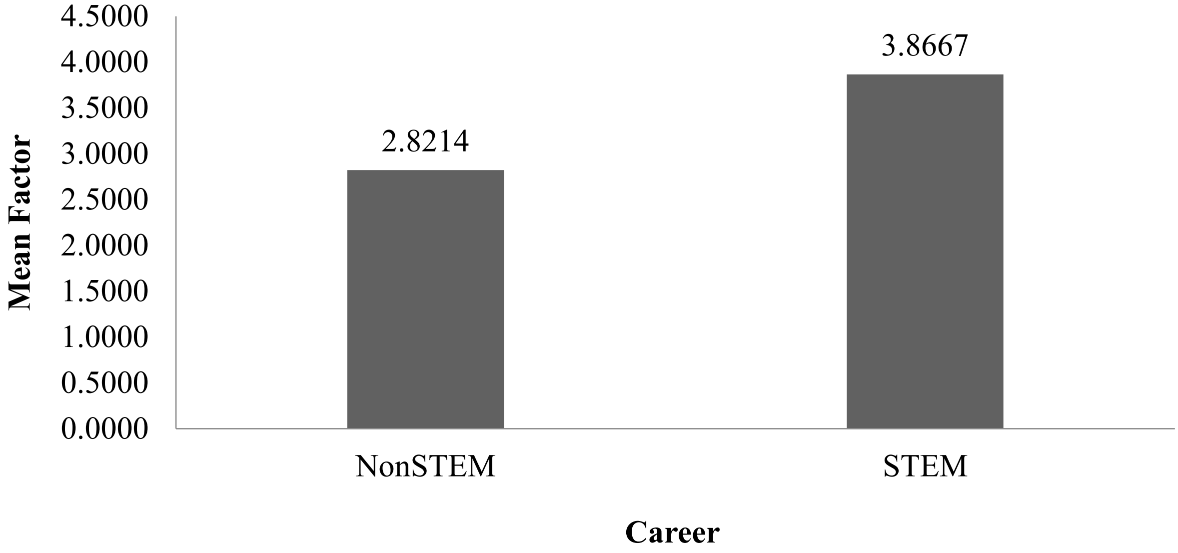

Figure 14. College internship or research.

There was a very substantial difference (37%) between the means associated with the STEM and Non-STEM respondents' in their participation in research or an internship program. The STEM participants were also more influenced by this variable than their Non-STEM counterparts (see Figure 15).

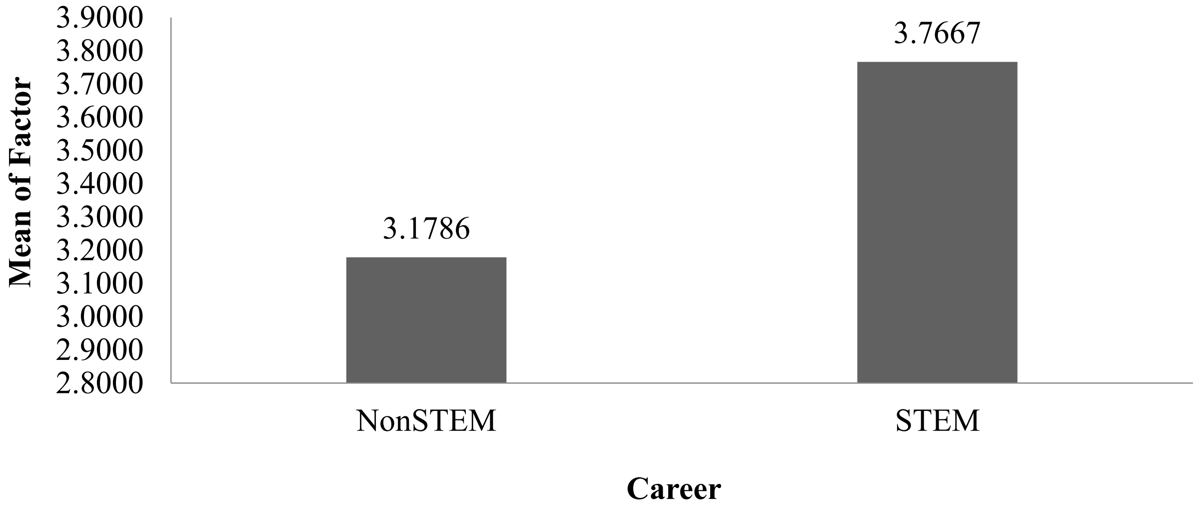

Figure 15. Means of factor, college professor that looks like me, by career.

There was a significant difference (18%) between the means of the STEM and the Non-STEM respondents in the exposure they had to the influence of college professors that looked like them in their decision to pursue a STEM career. This variable had a higher influence on STEM participants.

Although there were differences in the means of the variables, math as favorite subject (22%) and gender (27%), for STEM and Non-STEM respondents, the difference only approached statistical significance. Gender had a greater mean influence on Non-STEM respondents, while math as a favorite subject appeared to have a greater mean influence on the career decision of STEM participants.

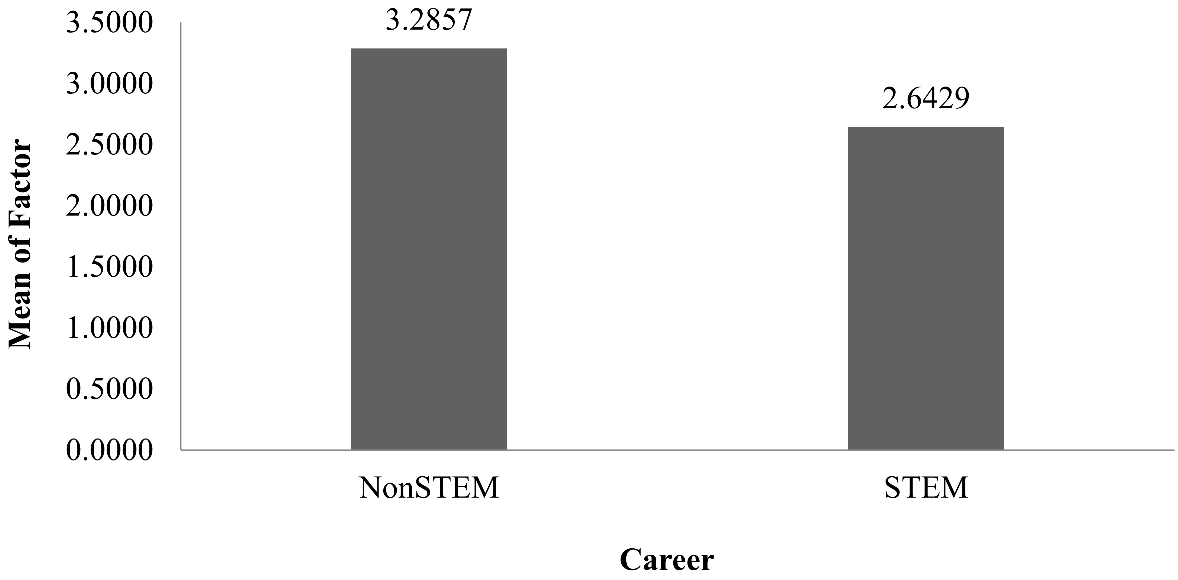

Figure 16. Mean of factor, gender by career.

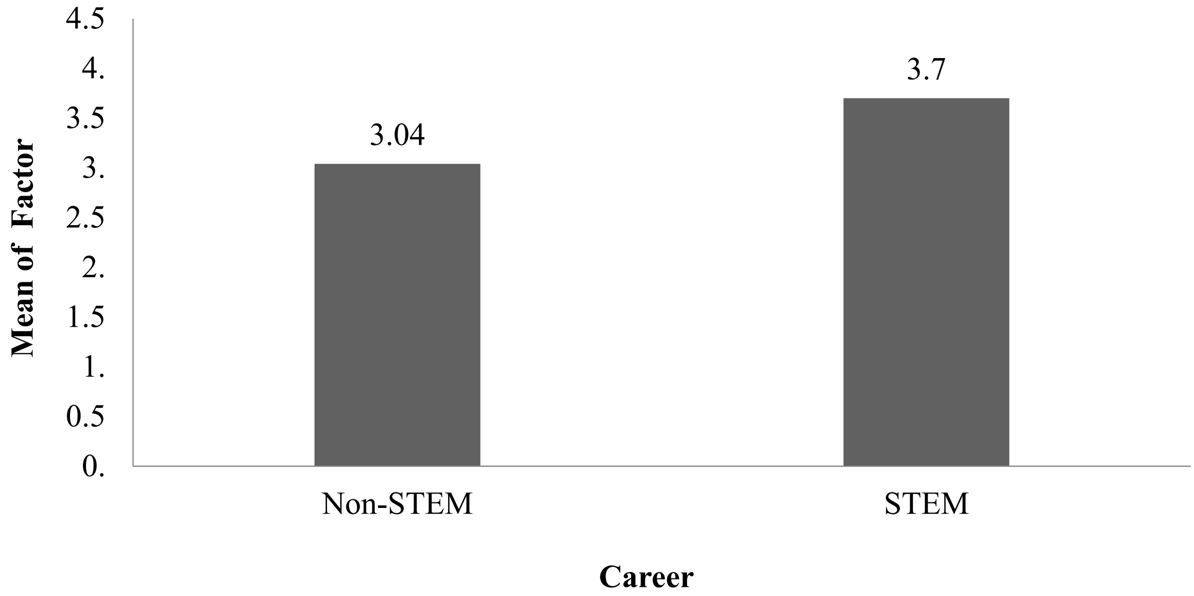

Figure 17. Mean of factor, math as a favorite subject, by gender.

Findings of the Qualitative Research

Qualitative analysis of the data was performed on some of the interval data collected in the survey. However, due to the amount of data available, it was decided to forego some of that analysis and concentrate on the quantitative analysis. Open-ended questions were asked about potential factors that may have influenced the respondents' decisions to pursue a STEM career. Those responses were coded, tabulated, and analyzed using correlation analysis, where each of those factors was considered as the independent variables, while the decision to pursue a STEM career was the independent variable. Some of those potential influencers included parental guidance, role models, grades, courses taken, extracurricular activities, socio-economic status, teachers' influence, and several others.

In the survey, the participants were asked about the person who influenced them the most in pursuing a STEM career; and they were given choices to choose from, including parents, other family, high school (HS) teacher, HS counselor, friend, role model, and film/book character. The participants could choose from *completely disagree*,

disagree, *neutral*, *agree*, or *completely agree*. A summary of the responses is shown in Table 6.

Table 6

Influencing Factors with Percentage of Responses (*n* = 306)

Influencer	1	2	3	4	5
Parents	14%	15%	22%	31%	28%
Other Family	24%	9%	35%	19%	14%
HS Teacher	21%	7%	33%	24%	16%
HS Counselor	39%	14%	36%	8%	2%
Friends	21%	13%	36%	23%	9%
Role Model	18%	7%	34%	24%	17%
Film/Book Character	38%	14%	31%	14%	4%

Questions were also asked about the factors which motivated participants to pursue a career in STEM. Those potential motivating factors they had to choose from were: personal satisfaction, financial stability, recognition, social acceptance, making the world better, pleasing the family, proving others wrong, moral/ethical concern, and lie finding solutions. Again, a scale of *strongly disagree* to *strongly agree* was used. The summary of those responses is shown in Table 7.

Table 7

Responses for Motivating Factors in Percentage

Motivating Factor	1	2	3	4	5
Personal satisfaction	0.04	0.02	0.12	0.34	0.48
Financial stability	0.11	0.07	0.26	0.38	0.18
Recognition	0.44	0.19	0.29	0.07	0.01
Social acceptance	0.33	0.15	0.35	0.14	0.02
Making the world better	0.11	0.04	0.3	0.32	0.24
Please family	0.31	0.16	0.33	0.15	0.04
Prove others wrong	0.45	0.45	0.28	0.07	0.05
Moral/ethical concerns	0.22	0.22	0.38	0.22	0.07
Like to find solutions	0.05	0.05	0.15	0.34	0.45

Parental influence, role model and HS teachers were named as the most influential people that impacted participants' decision to pursue a STEM career. Like to find a solution to problems, personal satisfaction, and making a better world were the top choices for motivational factors;

Summary

Only five of the dependent variables, the influencing factors, produced statistically significant differences for the sample, including both URMs and Non-URMs. However, six of them were found to be statistically significant when the same analysis included the subsample of URM sample population only. These variables showed *p* values below .05, therefore, were considered strong influencing factors in the decision to choose or not choose a STEM career. This analysis not only helped identify the factors that can influence the decision to pursue a STEM career, but it also showed whether those factors had an inversely proportional or a directly proportional influence in that decision. In Chapter 5, the researcher will attempt to compare the results from both sample populations and identify potential differences and reasons for those differences. Those findings will also be compared to the theories and assumptions found during the literature review for this study. That information can prove to be very useful as to where efforts and resources should be placed to motivate more URMs into STEM careers. It also helped identify areas where some of the factors are having a negative effect and is having an opposite effect than what it was intended. Additionally, the responses given to the qualitative portion of the survey, where participants were asked to identify the factors that influenced them to pursue a STEM career also provided a clear understanding of what are the primary variables impacting those career decisions.

Two analyses were undertaken for this study. The first analysis looked at the total (n = 318) population of respondents (URMs and Non-URMs) and attempted to identify all significant variables that affected their decision to pursue a STEM career. Under this correlation analysis, where the STEM *v*. Non-STEM decision of all respondents was considered the response or the dependent variable, while all the identified factors were considered the factors or independent variables, 19 variables were found to have a statistically significant *p* value of less than .05. The results are shown below in Figure 18.

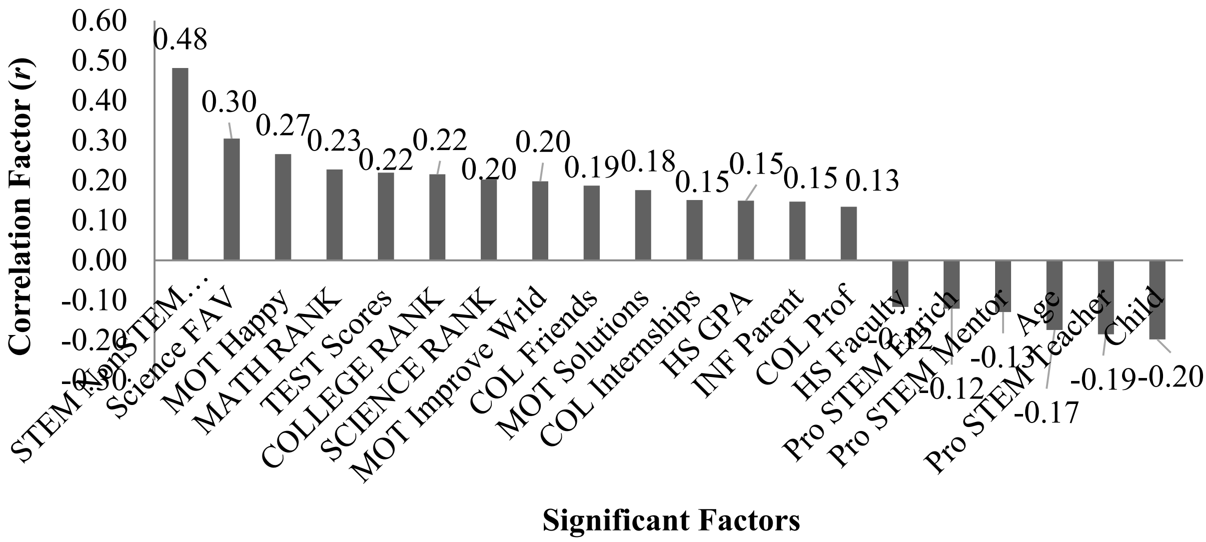

Figure 18. Significant variables for URMs and Non-URMs.

An Analysis of Variance (ANOVA) was also undertaken to refine the findings of the correlation better. Five variables were found to be significant factors affecting STEM *v*. Non-STEM decisions of all participants. Those variables were: age, HS math course ranked, HS faculty, college professor, and STEM enrichment program.

A similar analysis was also undertaken to analyze the potential factors only affecting URMs. Where the dependent variable was the STEM v. Non-STEM decision of only those respondents in the URM population of the sample (n = 62). In this analysis with the limited and smaller population, 11 variables were found to be significant. The results are shown below in Figure 19.

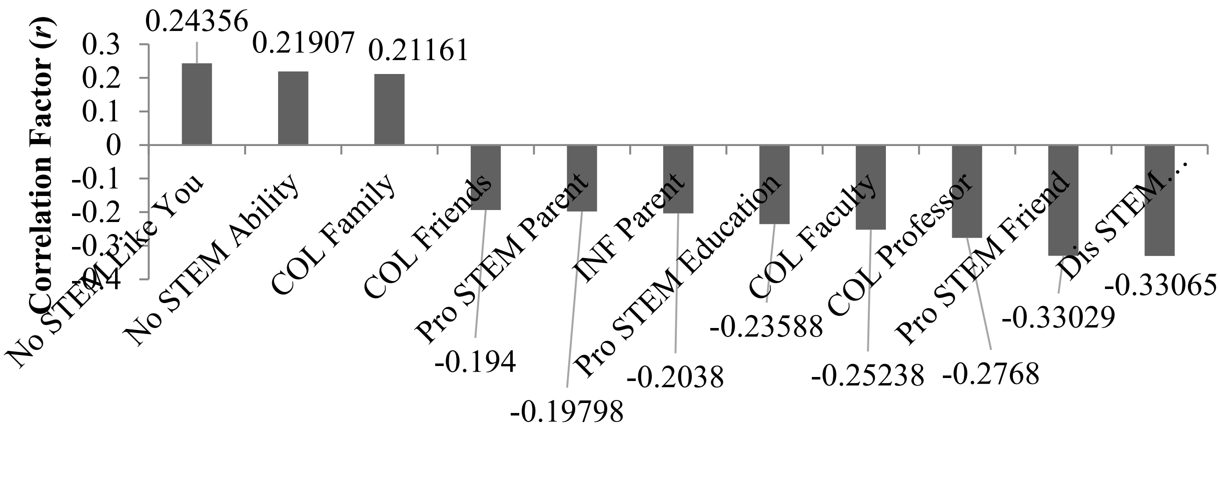

Figure 19. Significant variable for URMs.

As for the earlier analysis, an Analysis of Variance (ANOVA) was also undertaken to refine the findings of the URM-only correlation better. Six variables were found to be significant factors affecting the STEM *v*. Non-STEM decision among the URM participants. Those variables were gender, motivated by finding solutions to problems, Motivated by Happiness, HS Environment, HS Math as Favorite Course, HS Science as Favorite Course, College Professor, and College Internship. Gender (*p* value = .0506) and HS Math as Favorite Course (*p* value = .05259), did not technically make the cut as significant, since their *p* value was over the set threshold of < .05.

The overall assessment of these findings will result in clear identification of the most influential factors in the decision of STEM practitioners to pick their career path and profession. Those conclusions can be used to influence policies and programs aimed at increasing the number of URMs in the STEM workforce and bringing equity to the long-standing underrepresentation that has traditionally existed in the United States. The conclusions and recommendations derived from this data analysis are explained in Chapter 5.

CHAPTER 5: DISCUSSION

In this chapter, the researcher summarizes the research methodology, the data collection process, analyses, and the findings. He compares those findings to the research questions and the problem of practice guiding the current study. A comparison will also be drawn between the findings of this study, and the findings of other researchers, as found in the literature review. The researcher also realistically and without prejudice, assesses the validity of the findings based on the statistical validity of the sample population and on how well it represented the target groups that were being studied.

The researcher founded conclusions on a comprehensive literature review and sound research findings, drawing research-based recommendations that can ultimately influence more Underrepresented Minorities into STEM. The key research question of this study was: How are these barriers and motivators different for successful URM and non-URM STEM practitioners? It was answered by identifying the critical factors that can influence the students' career decisions and exploring ideas on how to use those factors effectively.

Summary of the Study

The study attempted to identify the reasons for which many underrepresented minorities (URMs) stayed in a STEM career, even though the majority of URMs shy away or drop out of these fields, resulting in a disproportioned underrepresentation. The primary research questions were: How are URMs motivated or influenced into choosing a career differently than Non-URMs? By finding and comparing the motivators and influencers that impacted the decision to pursue a STEM career, of the full population of respondents (n = 318), and the subset of that population only consisting of Underrepresented Minorities (n = 62);

The researcher created a survey instrument based on two theoretical frameworks, the expectancy value theory (EVT), and the social cognitive theory (SCT) which was aimed at the collection of valuable data about the factors and motivators that influenced STEM professionals into their fields. Questions were asked to participants about their expected values and outcomes, perceived costs, and self-efficacy, as well as the people and environment that guided and influenced them into their career paths. The specific goal was to identify existing effective strategies, policies, and programs that have made a positive impact on the career decision of successful URMs in STEM. By identifying the specific factors driven by those policies and strategies, the researcher attempted to highlight the best-proven practices which could inform the design of narrower and more focused programs.

The findings would thus be provided to policy-makers and program developers to help them streamline and manage available resources more efficiently to encourage URMs into STEM in a more focused and optimized manner. It is hoped that the current study will contribute to phasing out the "shotgun approach," whereby policymakers aim and hope that their strategy hits something, making a possible difference somewhere, somehow.

Implications for Practice

The findings of this study brought clarity and a greater understanding of the reasons for which certain ethnic groups are grossly underrepresented in the STEM fields. It also identified the factors and motivators that have traditionally guided other underrepresented minorities into STEM careers. The findings can be used to create programs and policies more efficiently through the appropriate allocation of resources into areas that can make a measurable positive difference.

The literature review has provided evidence of the underrepresentation of certain minorities such as Blacks, Latinos, Pacific Islanders, and Native Americans in STEM fields. It has become a goal at the highest levels of the government, academia, and businesses to address this situation; however, the multitude of efforts and a large amount of resources has brought minimal improvement. There are too many programs and incongruent policies guiding the distribution of billions of dollars in resources in a very fragmented and disjointed fashion, with little or no accountability for results (United States Government Accountability Office, 2012, 2018).

The current study can be used as a foundation for future studies to help narrow down one or two specific and unique factors that provide the highest level of influence into URMs' career selection. These factors can then be individually targeted to receive the bulk of the resources. This would make it possible to optimize the distribution of our resources and receive the "biggest bang for the buck."

Limitations

Although limitations are traditionally outside the researcher's control, it is important that they are identified, and their potential impacts addressed in the analysis and the final findings and conclusions. The main limitation of this study was the disappointing lack of participation by the targeted sample population, especially underrepresented minorities (URMs). The size of the sample population (n = 319), particularly of Underrepresented Minorities (46 Hispanic/Latinos, and 10 Blacks/African Americans) that completed the survey, was smaller than expected, which may have affected the statistical significance of some of the analyses. However, the disproportionate low level of response from URMs reflects the underrepresentation of these groups in STEM, which already existed in the community.

Objectivity and neutrality of the researcher, as well as that of the subjects being surveyed, could also affect and limit the effectiveness and reliability of the findings and conclusions. Although efforts were made to design the questionnaire in a way that would minimize the impact of potential biases such as the use of leading questions, the predisposition, personal background, and experience of participants could introduce a certain amount of bias in their responses.

Delimitations

Delimitations are self-imposed boundaries in the scope of the study that are set forth by the researcher early in the research process. The researcher delimited the sample population to members of professional STEM organizations and other STEM groups. The selection of the 100 professional organizations was purposefully based on the size and population of their membership. The purposive and stratified nature of the instrument limited the randomness of the sample and therefore could affect the validity of the findings.

The researcher focused only on the motivating and influencing factors that impacted participants' decision to pursue a STEM career, leaving out the identification of barriers and obstacles that often deter many URMs from taking that professional route. The population that is being sampled is assumed to have overcome those potential barriers and challenges, and they have successfully pursued and achieved a STEM profession. The research was also concentrated on participants belonging to all categories and levels of STEM jobs as defined by the U.S. Bureau of Labor Statistics and did not include jobs that may use scientific principles outside of the STEM community (Bureau of Labor Statistics, 2018).

The research aimed at attracting the new generation of students into STEM careers, thus the researcher placed a strong emphasis on the groups of respondents that shared the same values and technological background as the students in high school today. The researcher wanted to focus on the respondents within the group of 26 to 35-year-old; however, the overall response from that age group only consisted of 73 participants who represented only 23% of the sample population.

Recommendations for Future Research

It is important for future research to target URM populations more effectively, to get a higher rate of representative response. Future research can make use of a survey that would be more tailor-made to URM populations, and STEM groups and organizations that host

Blacks, Latinos, Pacific Islanders, and Native Americans. Examples of those organizations are the Society of Hispanic Professional Engineers (SHPE), National Society of Black Engineers (NBSE), Society for Advancement of Chicanos/Hispanics, and Native Americans in Science (SACNAS), American Indian Science and Engineering Society (AISES), Society of Mexican American Engineers and Scientists (Latinos in Science and Engineering), Association of American Indian Physicians (AAIP), and the National Action Council for Minorities in Engineering (NACME). Future studies on this subject should also include a large sample population which is sufficiently large to represent a statistical representation of URM; this would increase the level of validity and reliability of the findings. It would also be beneficial for research efforts to focus on a specific age group of participants that can relate to the values and technological skills of the new generation of students that we are trying to influence better.

The findings of the study point towards a factor, the “growing-up” environment, which deserves more attention in future research. It was a key influence in the decision of students to go into a STEM profession. It is clear that Bandura’s social cognitive theory and the concept of learning from the environment and the people in it should be fully incorporated into future surveys (Bandura, 2002). The questionnaire needs to concentrate more on the environments participants lived in and the people within that environment that helped shape their decisions to pursue STEM careers.

Future studies should focus on the influences of those with the most power to motivate our students, parents, family, teachers, and community. It would also be interesting to explore strategies to educate and train those that would help shape the career decisions of our students better. If our URM students are surrounded by people with no STEM background or ability to influence them into STEM careers, our URM students will continue to be underrepresented in STEM. Researchers should focus on categories of participants that are more likely to influence students.

Conclusions

A Pearson's correlation analysis was performed to examine the relationships between the 120 factors identified from the survey, influencing the pursuit of a STEM career. The decision to pursue a STEM career was considered the expected outcome, or the dependent variable. All the identified factors were considered the independent variables potentially influencing that outcome. From the 120 factors derived from the survey questions, only 19 showed a significant relationship to the expected outcome when a Pearson's correlation analysis was performed on the entire dataset (n = 318), reporting a p value < .05. The hypothesis that the factors and decision to pursue STEM were independent of each other was thus rejected. Those significant factors associated with the entire population of respondents (URMs and Non-URMs) were identified as: Age, Number of children, parental influence, motivated by happiness, motivated by improving the world, motivated by finding solutions to problems, ranking of HS math program, ranking of HS science program, naming science as favorite subject, influence by HS staff, HS GPA, SAT/ACT test scores, rank of undergraduate college attended, choosing a STEM or Non-STEM major, participation in college research or internships, college friends, participating in a STEM enrichment program, influence by STEM teacher, and influence by STEM mentor.

The direction and the strength of those relationships ranged from positive (directly proportional/same direction) to negative (indirectly proportional/opposite); and from strong to weak. The personal choice of picking or not picking a STEM major had the strongest relationship with the decision to pursue a STEM career with a positive correlation coefficient (r) of .48. Factors that had moderate positive relationships with decision to pursue a STEM career were: Science as favorite subject (r = .30), motivated by happiness (r = 27), ranking of

HS math program (*r* = .23), SAT/ACT scores (*r* = .22), the ranking of undergraduate college (*r* = .22), the ranking of the HS science program (*r* = .20), and motivated by improving the world (*r* = .20). There were weak positive relationships between six factors and decision to pursue a STEM career. These factors included: college friends (*r* = .19), motivated by finding solutions to problems (*r* = .18), having participated in college research or internships (*r* = .15), HS GPA (*r* = .15), parental influence (*r* = .15), and influence by college professor (*r* = .13). There was a moderate negative correlation associated with the number of children (*r* = -.20), and weak negative correlations to influence by STEM teacher (*r* = .19), age (*r* = -.17), influence by STEM mentor (*r* = -.13), participation in a STEM enrichment program (*r* = -.12), and influence by HS faculty (*r* = -.12).

A second Pearson's correlation analysis was also performed for a subsample of the population, which only included URMs (*n* = 62) so that a comparison could be drawn between the factors influencing URMs and the factors influencing all students into their career choices. This analysis yielded statistically significant relationships with only 11 variables: parental influence, STEM enrichment program, college faculty, college friends, college family, college professor, as well as positive influences such as Pro-STEM education, Pro-STEM parents, and pro-STEM friends, and negative influences such as No STEM like you, and No STEM ability.

For the URM-only sample population, negative or inverse correlations were found between decision to pursue STEM and eight factors: Parental influence (*r* = -.2038), STEM enrichment program (*r* = -.3306), college faculty (*r* = -.25238), college friends (*r* = -.194), college professor (*r* = -.2768), Pro-STEM education (*r* = -.23588), Pro-STEM parent (*r* = -.19798), and Pro-STEM friend (*r* = -.33029). Positive correlations were found for three factors: college family (*r* = .21161), No-STEM like you (*r* =.24356), and No-STEM ability (*r* = .21907).

The negative relationships mean that those variables had an inverse effect on the outcome. The direction of the influence and the effect are the opposite. For example, when the degree of parental influence, the amount of participation in a STEM enrichment program, the involvement of college faculty, college friends, or college professors increases, the level of positive impact on the career decision of URMs with respect to STEM careers, decreases. This implies that URMs are lacking the infrastructure and the support network needed from those that are supposed to be there to help them. Parents, teachers, friends, and professors are not adequately equipped to help students choose STEM to bridge the opportunity gap that they have faced for so long. We need to help those parents, teachers, friends and professors, so that they, in turn, could help the URM students.

From the results, the researcher concluded, without any doubt, that the ability and decisiveness of the participants had a major influence on their decision to pick a STEM career. Therefore, our goal should be to build that decisiveness and ability to decide early. By providing education and information on what those STEM careers have to offer, we should be able to influence their decision to join STEM fields.

The factors that had moderate positive influences with the attainment of a STEM career were motivated by improving the world or personal satisfaction and happiness, are rooted in the individual's experiences, and professional/ethical values gained throughout their upbringing and the surrounding cultural and social environment. According to Bandura's social cognitive theory, people's behaviors are shaped by what they see. These influential factors with moderate positive relationships with the attainment of a STEM career can be impacted by the people and the examples that young individuals are exposed to.

The other moderate correlation factors that signaled a preference for a STEM career can be traced back to high school and provide areas where we can identify an aptitude and interest in STEM. Those early signs are science as a favorite subject, in the ranking (rigor) of the math and science HS programs, and the SAT/ACT scores. By addressing these factors early, it is possible to influence the decision of HS students to pursue a STEM career.

Another moderate influencing factor involved in the decision to pursue a STEM career can be traced back to the higher education level: the ranking of the undergraduate college or the choice of college made during high school. It appears that STEM practitioners often chose colleges with a higher ranking to pursue their studies. The choice of college and the college ranking is a good indicator of the desire to go into STEM. Students' choice of a ranked college can be influenced early, and that choice could lead them to a STEM pathway decision. Weak positive correlations were also found, so the degree and amount of impact may be questionable. Those variables were identified as college friends, parental influence, motivated by finding solutions to problems, having participated in college research or internships, and influence by college professors.

Negative correlations were also found, which means that the relationship runs in a negative or opposite direction. For example, there was a moderate negative correlation between number of children and the attainment of a STEM career. This association tells us that the higher the number of children the respondents had, the least likely it would be for them to be in a STEM career. Although weak, the same inverse proportionality was also observed between attainment of a STEM career and STEM teacher influence, age, STEM mentor, STEM enrichment program, and HS faculty influence. This negative relationship means that for this sample population, the STEM teachers, mentors, and HS faculty had a negative impact on their decision to pursue a STEM career, therefore dissuading them from going that route. The results also showed that the younger the respondents, the less likely they were to join STEM fields. One finding that is counter-intuitive is the negative association between STEM enrichment programs and the attainment of STEM careers. STEM enrichment programs can often dissuade students from going into STEM; therefore, we need to ensure that those programs are designed and executed to motivate and encourage participation.

The qualitative questions of the survey asked the participants to assess and rank the most influential factors that affected their decision to pursue a STEM career. Some of these factors which were found to be weakly correlated with the attainment of a STEM career in the quantitative analyses were actually reported as major influencers when the question was asked in an open-ended format. Parental influence was listed as the greatest influencing factor, with college professors' influence playing a big part in their decision to remain in STEM. The literature also seems to agree on the strength of these factors, often citing them as some of the leading reasons influencing the decision to pursue a STEM career.

An additional analysis was performed on the complete dataset (n = 318) using an Analysis of Variances (ANOVA) to explore the relationship between the ethnicity of the respondents (Underrepresented Minorities or Non-Underrepresented Minorities), and each of the 19 variables that were identified as significantly related to the decision to pursue a career in STEM. The independent variable was the ethnicity, and the dependent variables were the 20 identified variables, which were found to give a statistically significant correlation with the attainment of a STEM career. The purpose was to find out if these variables statistically and significantly differed by the ethnicity of the respondents. This analysis yielded significant differences by ethnicity with five variables. These variables were HS math ranking, college professor influence, HS faculty influence, participation in a STEM enrichment program, and the age of the participants.

The researcher also performed a series of ANOVAs on the subsample of URMs (n = 62), to see if there were any variables that affected URMs' decision to pursue a STEM career significantly. The analysis was performed for the URMs dataset only, and the results yielded six significant variables (p value < .05). They were: Motivated by finding solutions to problems, motivated by happiness, HS environment, science as a favorite subject, college professor, and college internship. Two other variables came very close to being significant. They were math as a favorite subject (p = .05259), and gender (p = .0506). It is believed that if a larger sample population had been recruited, they would have produced statically significant results.

Most of the variables were found to have a moderate to weak influence on the decision of candidates to pursue a STEM career. This analysis also revealed that the ethnicity of the candidates has a measurable impact on the decision to enter into the STEM field. It was interesting for the researcher to compare the variables that were found to yield a significant result when using the overall general population data and those producing significant results when using the URM population data. They did not match, confirming that URMs are motivated differently than Non-URMs. URMs were motivated by more altruistic factors; they cited finding the solution to problems and happiness as reasons that motivated them to go into STEM. Thus, it would be beneficial for policymakers to offer early problem-solving workshops to URMs, provide exposure to the benefits of STEM careers, and emphasize how they correlate to a happy and fulfilling life. These strategies would help develop that motivation early in young URMs.

Parental influence, college friends, and college professors impacted the career decision of all participants, including URMs. However, two factors, being motivated by finding solutions to problems and happiness, were the leading motivators for URMs. In addition, several additional factors had a significant impact on URMs' career decisions. These variables were: HS environment, science as a favorite subject, college internships, STEM enrichment program, college faculty, college family, pro-STEM education, Pro-STEM parents, Pro-STEM friends, and No-STEM like you, and No-STEM ability. The researcher thus highlighted areas that may have the largest influence on Underrepresented Minorities in motivating participants to pursue a STEM career. The current findings can inform the appropriate allocation of scarce resources into targeted areas so that the impact is maximized, and the effort optimized.

From their HS experiences, the URMs give credit to the HS environment and having science as a favorite subject as influencing factors in their decision to pursue STEM jobs. The culture surrounding the student can, thus make a difference. It is thus important to tap into the potential of various stakeholders in shaping the culture, the value of parental and teacher guidance in educating and guiding students into a welcoming environment, and showing them that science can be fun cannot be overstated. Science fairs and hands-on experiments would help build self-efficacy and confidence, which develop student's motivation in studying STEM subjects and eventually pursue STEM careers. The same can be said about math; however, it did not rise to the level of a significant variable, possibly due to the smaller sample size used in the current study.

From the results of the analysis, the college experience was also found to have a large association with the decision of URMs to pursue and stay in STEM. The tutelage and guidance of college professors, college faculty, and the social/moral support from the college friends and family network around them were important. This fact underscores the need for students, especially URMs, to have a support network around them comprised of family, friends, and school faculty from whom they can get guidance and on whom they can rely. Folks in those roles need to understand the importance of being there for those students when they need them. Having parents and friends that support STEM also seemed to have helped URMs to stay in STEM and succeed at it. The same goes for having had a STEM Education, which allowed participants to familiarize themselves with STEM concepts, have early exposure to, and pursue a STEM type pathway.

Two negative factors that the URMs encountered and had to overcome were: having No person like me in STEM and being told that they had no STEM ability. The people in positions of impact (parents, teachers, media, etc.) should be educated and taught to exercise care when addressing young minds since their comments and attitudes can often impact their self-respect, self-efficacy, and self-confidence. This is a very important issue that needs to be addressed properly to eliminate biases, and shield students from dissuasion in pursuing STEM careers.

The Analysis of Variances (ANOVAs) performed on the total sample of URMs and Non-URMs (n = 318), and the subsample of URMs (n = 62) provided a better insight and a more accurate picture of the significant variables which were more likely to influence URMs and Non-URMs in their career choices. There were five significant variables that influenced URMs and Non-URMs; however, four of them seemed to be more effective with Non-URMs than they were with URMs. Only one of them seemed to have more influence on URMs than on Non-URMs. The four variables that had a stronger relationship with Non-URMs were; age, college professor influence, HS faculty, and STEM enrichment program. Age can be removed from consideration since the analysis only compared the mean age of both groups, with no significant impact on career decision making. College professors and HS faculty are "people around our students," and they can significantly influence them. The participation in a STEM enrichment program is also an experience that includes the influence of people that can teach and motivate students.

Another significant variable that seemed to resonate with URMs more than it did with Non-URMs was math ranking of the high school attended. As the researcher focused on this very important variable and attempted to establish how it influenced a career decision, he realized that being in a high school where math was highly valued exposed students appropriately to an environment rich in STEM ideas and concepts. An external environmental influence could shape the mindset and the values of students. According to Bandura's social cognitive theory, people learn by observing those around them.

When the researcher used ANOVAs to analyze the subsample of URMs ($n = 62$), he similarly discovered that only a small group of variables that influenced the participants produced statistically significant results (p value < .05). The analysis yielded six significant variables and two almost significant variables. The two variables that seemed to have a higher influence on Non-STEM URMs as compared to STEM URMs were gender and high school environment. Gender yielded an almost significant result since its p value only slightly exceeded .05. However, it is believed that a bigger sample size would have led to a statistically significant result. Gender discrimination is an issue which is not limited to STEM, so it can also be considered as impacting Non-STEM participants. Math as a favorite subject also approached significance; the researcher decided to include it in the list based on the same rationale.

There were two out of the six significant variables identified by the ANOVA carried out on the URM dataset, which had a higher influence on STEM URMs than on Non-STEM URMs. They included motivated by finding the solution to problems and motivated by happiness; both are values and attitudes that are formed during the formative years and influenced by surrounding people. Two other social factors that also influenced STEM URMs over Non-STEM URMs are college professors that look like participants and participation in college research or internships. Both factors include mentoring and counseling which can shape the decision-making ability of the students. Lastly, science and math as favorite subjects are greater influences on STEM URMs than on Non-STEM URMs. For a subject to be favored over another there needs to be exposure as well as a certain amount of self-efficacy associated with it. That does not happen by accident; it is usually a byproduct of parental or teacher guidance and encouragement. Those factors are similarly a direct consequence of the people and the environment to which students are exposed.

The ultimate goal of the study was to optimize resources and ensure that efforts were placed on areas that would make the biggest difference to the participation of URMs in STEM fields. Traditionally, billions of dollars and countless hours have been spent on fragmented efforts to solve the problem of the underrepresentation of URMs in STEM; however, the identification of one or two key influential factors can inform the redesign of these programs and adjustment of existing policies to better serve URMs interested in STEM.

The current study's findings suggest that interventions aimed at promoting STEM participation need to happen early in people's formative educational years, and the environment around them need to be built. The people need to be educated about how to display the future as a STEM practitioner as positive, fun, and promising. Children need to start looking up to scientists as role models and as people to emulate. They also need to be encouraged to do so, regardless of their ethnicity, or any other differences. The paradigm shift needs to start at the primary grades; STEM subjects such as math and English need to become required. This will provide the opportunity for students to engage in fun activities such as the design, building, and testing (at different levels of difficulty) of circuits, structures, mechanisms, and machines.

The strength of the relationship between the categorical demographic factors (gender, marital status, ethnicity, number of children, education, father's education, and mother's education) and the ethnicity data of URMs *v*. Non-URMs was tested using a chi-square analysis. Age and income were not tested since they were composed of interval data, which is not appropriate for chi-square analysis. It was found that only three out of the variables had a statistically significant relationship to URMs *v*. Non-URMs. They were: Ethnicity, father's education, and mother's education.

The education of the parents is thus also a factor that is associated with URMs *v*. Non-URMs. This finding begs another question: Do the common denominators and differences among URMs and Non-URMs differ based on the level of education of their parents. The data analysis on this topic was inconclusive since there were no discernible patterns or associations that could be drawn from the data. The low level of responses may be a logical reason for this issue. This finding reinforces an earlier assessment that highlighted that the environment within which students grow and learn plays a major role in the decision to go into a STEM career. It also reveals that the challenge does not lie on the generation of students in school today, but on the generation before them. Parental education is key to influencing students into STEM; thus, the responsibility is shifted to early childhood education, forcing the programs and policies to be directed not only at our students but also at their parents.

The research questions focused on the identification of motivational factors that could influence URMs into STEM fields effectively. They also focused on devising strategies to bring more URMs into the STEM workforce. The research questions were addressed using various analytical techniques, including Pearson linear correlations and ANOVAs. The factors that influence URMs best are the people and the environment around them, including the parents, family, teachers, schools, and communities. The most effective way to influence URMs into STEM is to design policies and programs not just aimed at the students, but also those around them. They should primarily be designed to educate those charged with raising, educating, advising, mentoring, and guiding our students. If we are to increase the number of URMs in the STEM fields, we need to support those who are likely to influence the students as they grow up. If the individuals around the students do not know STEM, it is likely that the students will not know STEM either. You cannot aspire to be something that you have not seen or know about.

Summary

The literature review and the findings of the current research revealed strong evidence of parental influence as a major factor in the decision of students to pursue a career as a STEM practitioner. However, the study does not reveal the necessary changes or conditions that need to be met for parents to exert that type of positive influence. Although parental education was outlined as a significant factor affecting the students' career decisions, the level of education, and the specific field of education that shape an effective influence are not identified.

From parental education and influence on the influence of teachers and mentors (in high school and college), it is clear that people in students' lives influence their career decisions. However, the shortage of URMs in the STEM workforce implies that the pool of STEM savvy URM adults available to advise and guide the pool of URM students is limited. A large majority of URMs are unfamiliar with or do not fully understand STEM careers. They would thus not be able to guide the students in that direction. Therefore, the lack of URM students entering STEM fields is expected to persist unless intentional effort is put into using research evidence to address the issue. STEM education cannot be limited to students but must expand to those that are around them through exposure and marketing, so they are equipped with the ability and opportunity to advise and guide them.

Other influential factors such as high school GPA, SAT/ACT scores, the rank of undergraduate college, ranking of math and science courses, and having science as a favorite subject can be considered byproducts of a decision that was already made. The effects of these factors may be attributed to the prior influence of parents and others. It was not an accident that students had a high GPA, high SAT/ACT scores, or chose to embrace science subjects; they got there because of the advice and guidance of those around them.

The theoretical framework used in this study was premised on both the expectancy value theory (EVT) and the social cognitive theory (SCT). The idea was to find the most often cited positive motivators associated with these theories' constructs and explore the strength of these influences on URMs' attainment of a STEM career. The EVT is grounded in the idea that if an individual feels confident that he or she can perform a task (self-efficacy), and that task has a high enough perceived value (attainment, intrinsic, and utility), while also having a relatively low cost, the individual will pursue that task. The SCT, on the other hand, basically addresses the environmental elements around us, and how those factors affect our perceived self-efficacy, and therefore our confidence to decide on a career. The theory basically states that our decisions are shaped by what we see and the examples that we are exposed to during our lifetime. Our study very convincingly confirms elements of this theory by showing that the most critical motivators impacting the URMs' decision to pursue a STEM career were related to the people around them and the environment in which they were raised. From parents to teachers and professors, it is clear that our students' decisions are based on the examples they see.

Bandura suggested that "observation and modeling" played a major role in the learning process. According to his social learning theory, most human behavior is learned observationally through modeling. Observation of others allows one to shape an idea of how new behaviors are performed, and subsequently, this coded information functions as a guide for action (Shrestha, 2017). He stressed that children could learn and imitate the behavior of those like them, similar to them, or around them. It was demonstrated by the famous Bobo Doll experiment, where children observed adults behave violently towards the doll, and later, when they were given the doll, the children replicated the same behavior. He also suggested that children learned by observing the negative consequences to a specific action, which often lead them to abstain from undertaking them (McLeod, 2016).

The validity of Bandura's theories was supported by the findings of this study; a direct correlation was established between the decision to pursue a STEM career, and various environmental conditions and influential factors. From parental and teacher influence, to the impact of role models, it is clear that children's behavior is highly influenced by the behavior and actions of those around them. This theory highlights the elements that are considered at the time people need to decide on the career to pursue. What participants saw, were told, and learned from those around them, are crucial factors influencing their career decision. If STEM is not in that environment or does not form part of the areas for which parents, teachers, or role models advocate, it is unlikely that the student would lean in that direction.

The research findings also indicate that factors such as parental, teacher, and friends' level of influence on the decision of STEM practitioners to pursue their particular careers, were highly influenced by the people surrounding them, who impacted their self-efficacy and belief that they could achieve in STEM fields. The other less, influential factors such as GPA, SAT/ACT, college ranking, and course ranking were considered byproducts or consequences derived from the influences mentioned earlier. However, they helped solidify and reinforce the respondents' beliefs of self-efficacy. Neither perceived values and expectancies, nor the cost of pursuing those careers, other than pursuing happiness and helping the world, played an important role in the decision to choose a STEM career. In conclusion, the constructs from the SCT had a higher degree of influence than those from the EVT on the decision to choose STEM.

By analyzing all the factors that had an influence or an impact on the decision of URMs to pursue a STEM career, there was one theme that emerged across the participant groups: parental guidance. It is clear by this analysis that educated parents can have a greater positive impact on the career decision of their children than parents that have never been exposed to higher education. The influence of high school faculty and college professors, and the participation in STEM enrichment programs also had a significant impact. However, these impacts traditionally came later in the students' lives; the STEM foundation and direction had already been set at home, by parents and family.

Table 8 showed that 28% of the respondents cited parents as the most powerful influence in their decision to pursue a STEM career, with role models, HS teacher, and other family as distant secondary influencers. These people, especially the parents, played a major role in shaping the career decision of participants, whereas the other significant variables were byproducts or consequences of those early influences. Variables such as GPA, choice of college, SAT/ACT scores, and preference for math and science, resulted from the guidance and tutelage of those who shared their vision and developed the participants' confidence/self-efficacy to pursue a STEM field.

Motivators, as shown in Table 9, are also derived from the values and principles taught by parents, family, and teachers. Motivators such as wanting to help make a better world, liking to find solutions to problems, and pursuing personal satisfaction and happiness are noble and holistic goals that have potentially been shaped by a positive home culture and caring environment. Although the makeup of the sample population recruited in this study did not represent the group of underrepresented minorities adequately, the study, nevertheless raised awareness of the underrepresentation of Blacks/African Americans, and Hispanics/Latinos in the STEM workforce. The sample showed that Whites and Asians are overrepresented, underscoring the importance of finding ways to bring equity to this issue.

One factor that may have had a major influence on the final make-up of the sample population of respondents is the age of those that took the time to take and submit the survey. Descriptive statistics show that 48% of the respondents were 45 years of age or older, while only 32% were 35 or younger. There were 20% in the age group of 36 to 45 years old. Despite the researcher's intent to sample a younger group of participants with a higher level of social, cultural, and ethical acceptability, the majority of participants were older. The findings of this study may thus reflect the values and prejudices of an older generation that could have skewed some of the results. Although the study may have been affected by the small sample size and the low participation by the targeted groups, the Underrepresented Minorities, it has provided valuable information about important motivational factors that influenced participants into STEM careers. It has provided a foundation on which future research in this area could be based.

Future research should include a survey that is tailor-made for identified minority groups that are underrepresented in the STEM fields. Furthermore, the recruitment strategy could be improved. Although mass e-mailing to organizations requesting the voluntary participation of their membership allowed the researcher to obtain a reasonable sample size, a personal appeal of collaboration may have worked better. Future researchers can seek assurance from the targeted organization's leaders that the survey would be distributed and that they would actively promote participation. Subsequent studies should also focus on finding out more about the environment and the people that could influence the URMs' decision to pursue STEM careers. Since the social cognitive theory seems to have a much more dominant influence than the expectancy value theory, there is a need for more emphasis to be placed on finding out more about the external and environment-driven influencing factors.

Despite the current study's limitations, the vast and rich amount of information that was obtained presents a very valuable opportunity to explore the issue of underrepresentation of URMs in STEM further. These findings point towards parents, family, teachers, schools, and communities as the primary motivators in the career decisions of students. It should be noted that if URMs are guided and counseled by other URMs; their chances of working in

STEM or knowing about STEM are low; therefore, the vicious cycle will continue until everyone that can influence is educated and has the know-how to guide students into STEM.

If policies are to be adjusted and programs redesigned to focus more effectively on research-based motivators and for available resources to be responsibly allocated, it is recommended that a more effective data collection approach is adopted. It is important to recruit a statistically representative sample of the populations being targeted, STEM practitioners, and URMs. These programs also need to be monitored, assessed, and calibrated, if the expected outcomes are not being met as originally intended. The policies and the corresponding funding also need to be focused on specific targets with very strict goals and expectations that are regularly monitored.

New policies and programs should target areas that are, for the most part, associated with the environment that the target population grew up in and the people they interacted with during that time, including the people in their home and school. Exposure to the various STEM options and witnessing people's success in those fields would create a positive environment and the awareness needed to increase STEM participation. However, for this condition to be realistically met, the education and awareness of STEM need to go beyond our students to extend to parents, teachers, community leaders, and the media. These people should understand what STEM is and what STEM can do so that they can adequately advise and guide the careers of those that depend on them. Parents and communities with high concentrations of URMs should primarily be targeted with this message. When underrepresented URMs join the STEM workforce, they not only break the cycle of underrepresentation but also fill up jobs in an area in which there is a high employment demand.

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APPENDICES

Appendix A

Solicitation and Introductory Letter

CONCORDIA UNIVERSITY IRVINE
DOCTOR OF EDUCATION IN EDUCATIONAL LEADERSHIP

Greetings:

Over the last few decades, there has been a decline in the number and quality of skilled workers entering the Science, Technology, Engineering, and Mathematics (STEM) workforce. The study in which you are being asked to participate is designed to identify positive factors and negative barriers that individuals experience in pursuing a career in STEM compared to those who pursued non-STEM careers. This study is being conducted by doctoral candidates, Francisco Alonso and Paul Woo, under the supervision of Dr. Eugene Kim, Dissertation Chair, Concordia University Irvine, School of Education. This study has been approved by the Institutional Review Board, Concordia University, Irvine in Irvine, CA.

As two high school teachers pursuing our Doctorates in Educational Leadership, we have seen a critical decline in interest by our students when it comes to pursuing careers in the fields of STEM. We have also heard and read from many industry experts, governmental agencies, and potential employers about how this decline in volume and quality of candidates could lead to an employment crisis and have a major detrimental economic impact in our society, as we continue to lose our competitive edge and technological lead in the global market.

We have an opportunity to help alleviate this potential problem and avert this projected crisis by identifying ways to effectively motivate and prepare our students to pursue the STEM careers of tomorrow. The survey has some questions geared toward STEM professionals, but we also need input from those not working in STEM. Please answer each question to the best of your ability. The survey will take between 15 to 30 minutes to complete. Click the attached link to read the Informed Consent Form and participate in this study. Your candid and honest response could be the key to identifying new ways to get more of our students to choose to pursue a career in STEM! In order to create positive change, we need to work together, and you can help make that difference.

We are also asking that you forward this letter to co-workers, encouraging them to make a difference by participating in this very important study. The survey will be accessible until Wednesday, May 15, 2019. If you have any questions or comments regarding this study, please contact Francisco Alonso at francisco.alonso@eagles.cui.edu or Paul Woo at paul.woo@eagles.cui.edu.
As avid STEM education advocates, we would like to thank you in advance for taking part in this important research and for making the positive difference that will help our students, impact our economy, and have lasting effects for generations to come.

Respectfully yours,
Francisco J. Alonso and Paul P. Woo
Concordia University, Irvine

https://www.surveymonkey.com/r/STEMSurvey2019fapw

If the link does not automatically open, please copy and paste the link into your web browser.

Appendix B

Survey

1. What is your gender?

- Male
- Female
- Other

2. How would you describe your ethnicity?

- Asian
- Black/African-American (Non-Hispanic)
- Hispanic/Latino
- Other (please specify)
- Native American
- Pacific Islander
- White/Caucasian (Non-Hispanic)

3. What is your age?

- Under 25
- 25 - 35
- 36 - 45
- 46 - 55
- Over 55

4. What is your marital status?

- Single
- Married
- Divorced/Separated
- Widowed

5. What is your individual annual income?

- Under $50 K
- $50 K - 60 K
- $61 K - 70 K
- $71 K - 80 K
- $81 K - 99 K
- $100 K or more

6. What is the highest level of education you have completed?

- High School
- Bachelors Degree
- Associate Degree
- Masters
- Technical or Vocational Certificate
- Doctorate

7. What is the highest level of education your **father** completed?

- Elementary school
- Bachelors degree
- Junior High/Middle School
- Masters degree
- High school
- Doctorate
- Vocational/Technical/Associates Degree

8. What is the highest level of education your **mother** completed?

- Elementary school
- Bachelors degree
- Junior High/Middle School
- Masters degree
- High school
- Doctorate
- Vocational/Technical/Associates Degree

9. What math courses did you complete in high school? Check all that apply.

- [ ] Algebra I
- [ ] Statistics
- [ ] Geometry
- [ ] AP Calculus AB
- [ ] Algebra II
- [ ] AP Calculus BC
- [ ] Precalculus
- [ ] AP Statistics
- [ ] Calculus
- [ ] Other (please specify)

10. Which science courses did you complete in high school? Check all that apply.

- [ ] Biology
- [ ] Anatomy/Physiology
- [ ] Chemistry
- [ ] Environmental Science
- [ ] Physics
- [ ] Other (please specify)

11. To what extent would you agree that your high school offered a rigourous:

	1 - Completely Disagree	2	3 - Neutral	4	5 - Completely Agree
Mathematics Program	◯	◯	◯	◯	◯
Science Program	◯	◯	◯	◯	◯

12. Please answer the following questions using the scale 1-Completely Disagree to 5-Completely Agree

	1- Completely Disagree	2	3-Neutral	4	5-Completely Agree
Math is my favorite subject.	◯	◯	◯	◯	◯
Science is my favorite subject.	◯	◯	◯	◯	◯

13. Please list any summer STEM enrichment programs you participated in while in high school. If you did not participate please skip to the next question.

Program:

Program:

Program:

Program:

14. What STEM clubs or organizations have you participated in? If none please skip to the next question.

Club/Organization:

Club/Organization:

Club/Organization:

Club/Organization:

15. Influenced you to pursue STEM.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Parents	◯	◯	◯	◯	◯
Other Family Member	◯	◯	◯	◯	◯
Instructor/Counselor	◯	◯	◯	◯	◯
Friend/Peer	◯	◯	◯	◯	◯
Role Model/Mentor	◯	◯	◯	◯	◯
Film/Book Character	◯	◯	◯	◯	◯

Other (please specify)

16. The primary reason I pursued a career in STEM.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Personal satisfaction/happiness	◯	◯	◯	◯	◯
Financial wealth/stability	◯	◯	◯	◯	◯
Recognition/Fame	◯	◯	◯	◯	◯
Social Acceptance	◯	◯	◯	◯	◯
To make the world a better place	◯	◯	◯	◯	◯
To please my family	◯	◯	◯	◯	◯
To prove others wrong	◯	◯	◯	◯	◯
Moral/ethical concerns	◯	◯	◯	◯	◯

Other (please specify)

17. Dissuaded you from pursuing STEM.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Parents	◯	◯	◯	◯	◯
Other Family Member	◯	◯	◯	◯	◯
Instructor/Counselor	◯	◯	◯	◯	◯
Friend/Peer	◯	◯	◯	◯	◯
Role Model/Mentor	◯	◯	◯	◯	◯
Film/Book Character	◯	◯	◯	◯	◯

Other (please specify)

18. The reason I was given not to pursue a career in STEM.

	1-Completely Disagree	2	3-Neutral	4	5-Completely Agree
Low math skills/ability	◯	◯	◯	◯	◯
Lack of financial resources	◯	◯	◯	◯	◯
People "like me" did not work in STEM fields	◯	◯	◯	◯	◯
You are not good enough	◯	◯	◯	◯	◯
STEM is too difficult	◯	◯	◯	◯	◯

Other (please specify)

19. To what degree would you agree that the following were positive factors to your successful employment in STEM?

	1- Completely Disagree	2	3-Neutral	4	5-Completely Agree
Education	◯	◯	◯	◯	◯
Enrichment Program	◯	◯	◯	◯	◯
Ethnicity	◯	◯	◯	◯	◯
Parent	◯	◯	◯	◯	◯
Family Member (Other than parent)	◯	◯	◯	◯	◯
Friend/Peer	◯	◯	◯	◯	◯
Gender	◯	◯	◯	◯	◯
Instructor/Professor	◯	◯	◯	◯	◯
Mentor/Role Model	◯	◯	◯	◯	◯
Socioeconomic Status	◯	◯	◯	◯	◯
Self-Confidence	◯	◯	◯	◯	◯
Early Exposure	◯	◯	◯	◯	◯
Welcoming Social Environment	◯	◯	◯	◯	◯

20. To what degree would you agree that the following were negative barriers that you experienced to your successful employment in STEM?

	1- Completely Disagree	2	3-Neutral	4	5-Completely Agree
Education	◯	◯	◯	◯	◯
Enrichment Program	◯	◯	◯	◯	◯
Ethnicity	◯	◯	◯	◯	◯
Parent	◯	◯	◯	◯	◯
Family Member (Other than parent)	◯	◯	◯	◯	◯
Friend/Peer	◯	◯	◯	◯	◯
Gender	◯	◯	◯	◯	◯
Instructor/Professor	◯	◯	◯	◯	◯
Mentor/Role Model	◯	◯	◯	◯	◯
Socioeconomic Status	◯	◯	◯	◯	◯
Lack of Self-Confidence	◯	◯	◯	◯	◯
Lack of Exposure	◯	◯	◯	◯	◯
Unwelcoming Social Environment	◯	◯	◯	◯	◯

21. In which field are you employed?

◯ Engineering

◯ Computer Science

◯ Medical/Health Care

◯ Education

◯ Other (please specify)

22. What is your job title?

23. How many years have you been working in this field?

- Less than 1 year
- 1 - 3 years
- 4 - 5 years
- 5 - 10 years
- More than 10 years

24. Describe someone who influenced you to pursue STEM. (Approximately 100 words or less).

25. Describe a barrier you had to overcome to get to where you are now in your career. (Approximately 100 words or less).

26. Describe why someone you know dropped out of STEM during or after college. (Approximately 100 words or less).

27. Would you be willing to participate in a follow up one to one interview?

- Yes
- No

28. If you answered yes, please enter your contact information

Name

Email Address

Phone Number

Appendix C

Survey Consent Form

The Shortage of Women in STEM: Engineering and Computer Science

The study in which you, as a member of the STEM community, are being asked to participate is designed to identify positive factors that would encourage and influence students to pursue careers in the specific STEM professions of engineering or computer science; and to identify negative barriers that would dissuade students from pursuing careers in these specific fields. Over the last few decades there has been a decline in the number and quality of skilled workers entering the STEM workforce. That employment shortage is predicted to create a national economic crisis that threatens to erode the economic global standing of the U.S. In addition, it has been documented that women are underrepresented in the specific fields of engineering and computer science. By identifying the positive factors and negative barriers policies and procedures may be developed to bring equity in the representation of women in these fields. This will also bring greater diversity and equity to the STEM workforce. This study is being conducted by Paul Woo under the supervision of Dr. Eugene Kim, Dissertation Chair, Concordia University Irvine, School of Education. This study has been approved by the Institutional Review Board, Concordia University Irvine, in Irvine, CA.

PURPOSE: The primary purpose of this study to identify the positive factors and negative barriers that women have experienced in attaining their career in engineering and/or computer science, and to encourage young women to pursue STEM careers in engineering and/or computer science. As a result, we would also be able to address the projected STEM employment gap, by supplying qualified workers from the traditionally marginalized demographic areas of our population. The idea is to close the employment gap, bring equity in the representation of women in the specific fields of engineering and computer science, and diversify the STEM workforce with a single unified effort.

DESCRIPTION: This study is designed to explore the positive factors that influenced successful and established STEM practitioners like you, to pursue and achieve a STEM career in engineering and/or computer science. By identifying those key positive factors that motivated you to pursue, persist, and achieve your goal; we should be able to create effective standard policies, programs and procedures that would be effective for young women at every level. The research begins by selecting a statistically representative sample of our STEM population that has similar values, expectations, interests, and technological background as the students we are trying to motivate. To reach that very specific segment of our population, the researcher solicited the help of about 100 professional organizations associated with STEM. The goal is to have the organizations disseminate the links to the on-line questionnaire to their members and have the members provide the responses at an individual level. The responses will then be tabulated and analyzed, and the conclusions drawn will be used to develop policies and programs that will make the difference that we need, in creating equity in engineering and computer science.

PARTICIPATION: Please note that participation in this survey is totally voluntary, and you, as a potential participant, have the right to refuse, withdraw, or discontinue participation at any time without any type of penalty or loss of benefits to which you are otherwise entitled.

CONFIDENTIALITY OR ANONYMITY: Your responses to this survey will be recorded by an on-line survey, and your personal or identifiable information will strictly confidential. Complete anonymity will be provided, so your responses or your participation will never be associated or connected to you. In addition to anonymity, this survey will be conducted with the highest level of professionalism and ethics, and there will be no dissemination of the data to anyone. After the study is completed the data will be safely stored in a password protected, secured and safe environment for a period of 5 years.

DURATION: The participant should expect to spend between 15 to 45 minutes completing the survey.

RISKS: There are no foreseeable risks or discomforts to the participants associated with this survey, however some of the questions may bring up some memories that could be associated with negative experiences or unpleasant episodes in their life. The risk of confidentiality breach is always there, due to the evolving and unstable environment associated with electronic data security, and theft.

BENEFITS: There are no monetary or tangible benefits associated with the participation in this research, however there should be a sense of pride in knowing that your participation will be a potential direct contributor to averting an economic crisis and bringing a much-needed diversity to the STEM workforce.
VIDEO/AUDIO/PHOTOGRAPH: Only those who voluntarily participate in the one to one interviews will be recorded. These video interviews will be safely stored in a password protected, secured and safe environment for a period of 5 years.
CONTACT: If you have any questions about the research, the data collected; or the rights of those participating in the on-line survey, including any type of injury or damage, please contact the researcher at paul.woo@eagles.cui.edu, or at (714) 914-3452, or the advisor Dr. Eugene Kim at eugene.kim@cui.edu or at (949) 333-9188.
RESULTS: After the data is collected, compiled and analyzed; and the study is completed and published, the results will be available at: Concordia University, Irvine Library
CONFIRMATION STATEMENT:
I have read the information above and agree to participate in your study. **Or**
I have read and understand the consent document and agree to participate in your study. **Or**
I understand that I must be 18 years of age or older to participate in your study, have read and understand the consent document and agree to participate in your study.

SIGNATURE:
Signature: ________________________________ Date: ___________________________
Printed Name: ____________________________

The extra copy of this consent form is for your record.

Appendix D

IRB Approval Email

Ticket closed: CONCORDIA UNIVERSITY IRVINE INSTITUTIONAL REVIEW BOARD PROTOCOL REVIEW
IRB Protocol Number: 4882
IRB Approval Date: 3/14/2019

Mr. Alonso and Mr. Woo
Congratulations! Your research proposal has been approved by Concordia University-Irvine's IRB. Work on the research indicated within the initial e-mail may begin. This approval is for a period of one year from the date of this e-mail correspondence and will require continuation approval if the research project extends beyond a year.

If you make significant changes to the protocol during the approval period, you must submit a revised proposal to CUI's Institutional Review Board (IRB). Please write your IRB # and "EdD IRB Application Addendum # (and the IRB Protocol number)" in the subject line of any future correspondence.
If you have any questions regarding the IRB's decision, please contact me by replying to this e-mail or by phone at 512 810 9172
Kind Regards,
Blanca Quiroz
EdD IRB Reviewer