IDENTIFYING AND MITIGATING BARRIERS TO INCREASE THE NUMBER OF UNDERREPRESENTED POPULATIONS IN STEM EDUCATION AND WORKFORCE

by

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ABSTRACT

Although there has been extensive research on STEM and underrepresented populations, including studies related to underrepresented minorities' (URM) barriers to STEM and practices to increase the visibility of URMs in STEM, additional research and data reveal the impact of social and cultural barriers that contribute to explicit racial and gender gaps in STEM fields. While education systems are leading pioneers for producing quality STEM workers, the lack of workforce diversity and unconscious and conscious bias is a systemic problem that contributes to gaps in the STEM workforce. Amidst racial injustice that ignited the March 2020 protests and Black Lives Matter movement, fifty-year-old discussions surrounding racial disparities continued. The protests and Black Lives Matter movement did not only touch on racial injustice, they illuminated a long history of systemic racism and how it has obstructed quality educational experiences and occupational success for people of color in the U.S.

Understanding the history of the development of barriers and education for minorities is an integral part of understanding key factors such as the attitudes, perceptions, and priorities of underrepresented minorities in the present time.

This research study provides a summary of existing literature and identified themes as it relates to the impact race, gender, and education on STEM; the impact of belief systems on STEM career aspirations; and strategies to mitigate the barriers. The findings in this review may serve many stakeholders including community college leaders, K-12, industry, policymakers, and most importantly, URM students.

Keywords: Underrepresented Minorities/ Populations; STEM; Skills Gap; Social Barriers; Cultural Barriers; and STEM Workforce

DEDICATION

The completion of this chapter in my life is dedicated to those who valued my worth and saw me before I saw myself, including my absolutely AMAZING supportive and loving family: my mother, Debbie Louise Cross-Johnson, my father, Arthur Lee Cross, my four sisters, my 16 nieces and nephews, my late great-uncle Johnny W. King (Uncle Bubba), and my FUTURE. We've broken the cycle!

Finally, I dedicate this dissertation to my number one supporter, my husband, MSgt John Grayland Wilson, who was there with me from the beginning to the end. His love and understanding helped me through so many challenging times on this journey. It was through his guidance, patience, and unwavering love that I remained grounded, focused and motivated beyond measure. For that, I am forever grateful. Here's to my John!

"We love because he first loved us."
1 John 4:19

Tomeka C. Wilson

My career and the basis of my educational decisions would not be possible without the example and guidance of my parents, Dorothy and Earl Farr. Their example and their sacrifice have guided my educational path with encouragement, knowledge and love. I'm honored to be your pride and joy.

My husband, Dr. Benjamin Newton, has shown me that perseverance and dedication leads the way to obtaining goals. He has supported my decisions with my career and my education from the first day I met him. Without his love, support, and understanding, this journey would have seemed impossible. He is my voice of reason, my life partner, and my anchor.

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For each of you, I am eternally thankful.

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We wish to thank our DCCL family, especially the "Great" cohort 8, the participants in the study and our dissertation committee. Without their guidance, we would not have made it. Dr. Sandra Balkema, Dr. Bridget Ingram, and Dr. John Reutter, III, served as engaged and wise committee members and went above and beyond to help us reach our goals. Each of you are extraordinary professionals who have dedicated so much to research, discussions, and the community college mission. THANK YOU!

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Chapter I: Introduction

> One of the greatest strengths of the American talent pool and workforce is diversity. But unnecessary barriers and the impact of bias too often limit who pursues, persists, and succeeds in STEM. To engage the diversity of Americans more fully, access the full potential of the STEM talent pool, and provide equitable opportunities, we as a Nation must respond to the growing research on the impact of implicit barriers and unconscious bias driving interested students away from STEM.
>
> President Barack Obama, STEM for All, February 2016

Background of the Problem

Science, technology, engineering, and mathematics (STEM) fields have been pertinent to the development and function of society over the past century (White, 2014), and are more essential with greater reasons today, especially due to challenges surrounding the global coronavirus (COVID-19) pandemic. The pandemic has transformed how healthcare workers care for patients, how industry operates, how educators educate, and how people live their lives (Ahmad, 2020; Elzar & Tam 2020; Pew Research Center, 2020). It is evident that more skilled scientists, researchers, healthcare workers, and engineers are needed more than ever during this time of uncertainty to maintain a healthy and robust society and economy. However, the skills gap between what is needed in the STEM workforce and provided by educational systems is a constant evolving issue with no clear solution.

Education leaders, economists, and policymakers have deliberated over several decades on how to best address the matter (Burrowes et al., 2013; Kochan et al., 2012). Understanding the skills gap, including barriers to accessing and persisting in STEM education and workforce, is critical to solving the problem. The “skills gap” itself is often credited to a failure of the United States education system, and the education systems that are increasingly being held accountable for the skills shortage are the community colleges and universities (Koc, 2018). Some STEM-related organizations and industries claim all levels of education systems, including K-12 and community colleges, are not producing STEM graduates who are workforce ready (Bauer-Wolf, 2018; Casner-Lotto & Barrington, 2006). While education systems may be held accountable and leading pioneers for producing quality STEM workers, Ioannou (2018) noted that the lack of workforce diversity and unconscious and conscious bias is a systemic problem that contributes to gaps in the STEM workforce. Amidst racial injustice that ignited the March 2020 protests and Black Lives Matter movement, fifty-year-old discussions surrounding racial disparities continued. The protests and Black Lives Matter movement did not only touch on racial injustice, it illuminated a long history of systemic racism and how it has obstructed quality educational experiences and occupational success for people of color in the U.S. (Kurtz, 2020). Research and data reveal explicit racial and gender gaps in STEM fields have resulted from social and cultural barriers (Funk & Parker, 2018). In addition to developing skilled workers, these barriers will also need to be identified and addressed.

According to the National Action Council for Minorities in Engineering (NACME) and a report published by U.S. Government Accountability Office (GAO) in 2017, African Americans and Hispanics along with other racial and ethnic minorities are underrepresented in STEM (NACME, 2013; GAO, 2017) compared to their representation in the overall general workforce. These findings have also been linked to low levels of education attainment among specific racial/ethnic groups and genders. Studies and statistical data continue to show a persistently large gap in education and employment attainment between minority groups, with women inclusive and White males since the 1940s (National Center for Education Statistics, 2017). Subsequently, the American workforce has been formed by historical White male authority (Gee, 2018) that continues to subordinate underrepresented populations in the workforce, including STEM—it is not clear whether it is intended or not in the 21st century. On the contrary, a number of research studies concluded that the under-recruitment and engagement of minority groups in STEM starts in their homes and secondary educational experiences. This outlook ultimately translates into an obvious gap between the number of students who will pursue higher education, including STEM degrees, and those who will not.

Defining the STEM Workforce "Skills Gap"

Ironically, buzzwords, such as "STEM" and "manufacturing" are often paired with the "skills gap." A skills gap means that there are plenty of jobs or strong labor demand, but not enough qualified workers to fill them (Needleman, 2014). While studies and reviews argue there is a skills gap, Cappelli (2012) challenges the idea that there is no skills gap because there is no evidence to support the notion. Cappelli, in fact, suggested that there is a training gap, instead of a skills gap (p. 69-71). Some will argue that the training gap and skills gap are the same thing. If you were to separate the terms, training and skill, according to the Webster and Business dictionaries, training is the act, process, or method of one that trains, and skill is considered a learned power of doing something competently that more than likely derives from training. This issue has become controversial because people mean different things by "skills gap" (Bessen, 2014), which may also contribute to the different meanings of the STEM workforce. Various reports employ different definitions of the STEM workforce. According to the National Science Foundation (NSF, 2015b), the STEM workforce has many sub-workforces and consists of many types of workers who employ significant STEM knowledge and skills in their respective STEM groups. The National Academies of Sciences, Engineering, and Medicine (2017) defines the STEM as:

> the scientists and engineers who further scientific and technological progress through research and development (R&D) activities, workers in non-R&D jobs who use STEM knowledge and skills to devise or adopt innovations, and workers in technologically demanding jobs who need STEM capabilities to accomplish occupational tasks. (p. 58)

Although the combined terms "STEM workforce" has been widely used and cited, there is no general consensus on how the term is defined. O'Net Online, a database for occupational information developed for the U.S. Department of Labor by the National Center for O*NET Development, identified 308 STEM-related occupations that required an education in science, technology, engineering, and mathematics disciplines (National Center for O*NET Development, 2016). However, the Pew Research Center 2018 analysis of the United States STEM workforce identified 74 occupations that were classified as STEM workforce occupations by the U.S. Census Bureau's American Community Survey (Funk & Parker, 2018). These occupations were also referenced by NSF (2015b, 2016, 2018) in recent reports. According to the report, the occupations included physical and life scientists, computing and mathematical workers, engineers and architects, and healthcare practitioners and technicians (Funk & Parker, 2018). Healthcare support positions, such as nursing aides or medical assistants, did not classify as STEM occupations (Funk & Parker, 2018). All STEM workers identified in the survey had some type of post-secondary education or training, which included bachelor's and advanced degrees, as well as associate's degrees and other credentials (Funk & Parker, 2018). Since the 1950s, the education and job attainment data published by the Bureau of Labor Statistics (U.S. Census Bureau, 2017) has shown a higher percentage of underrepresented populations with less than a high school degree than non-underrepresented populations. The 1950s and 1960s were a time when education and employment opportunities and access were not equal for all US.S.

citizens, which sparked the Civil Rights Movement. Although the movement ignited equal rights and desegregation in education, research has identified the presence of gaps in occupational and educational attainment. These findings may indicate the low number of minorities employed in STEM workforce occupations since these particular occupations require some form of post-secondary education and/or credentials.

STEM Occupation Projections

Recent data from the Employment Projections program reported by the U.S. Bureau of Labor Statistics (2019) projected an 8.8% increase in employment in STEM occupations by 2028. As defined by the U.S. Bureau of Labor Statistics (BLS), STEM consists of one-hundred occupations, including life and physical sciences, architecture and engineering, math, and computer and technology-related occupations. BLS also recognizes occupations, such as teaching and managerial positions that require technical or scientific knowledge at the postsecondary level, as STEM-related occupations (BLS, 2020). Fayer et al. (2017) documented that at least 20 of the top fastest growing occupations in the STEM group will require at least an associate's or bachelor's degree by 2024. The computer and technology occupations are projected to grow the fastest by 2028 at 12% (BLS, 2019) and mathematical science occupations, which include statisticians and mathematicians, are projected to grow by 2024 at 28.2% among the STEM occupations, compared to the projected average growth of all occupations of 6.5%, STEM and non-STEM (Fayer et al., 2017). Other STEM occupations, such as graphics technology, draftsman, cartographers, and engineering technicians will hardly increase by 2024 (BLS, 2017; Fayer et al., 2017).

While engineering technician positions may see little to no change, distinct engineering occupations will have about 65,000 jobs available before 2025, which will more than likely secure the second fastest growing STEM occupation in the U.S. after computer occupations. Computer and Information occupations are expected to grow the fastest due to the demand for greater focus on the collection and storage of big data, cloud computing, and information security (BLS, 2019), especially since the U.S. is more vulnerable to cyber-attacks due to the COVID-19 Pandemic (U. S. Department of Homeland Security, 2020). These fields will require technical training and/or a post-secondary degree (Fayer et al., 2017). Substantial technical expertise in STEM fields will be required to manage a health crisis of this magnitude (Seale, 2020). While the lack of diversity in the STEM workforce appears to be a diminishing and possibly irrelevant topic during the challenges related to the COVID-19 pandemic, educational attainment still remains at the top of U.S. agenda (U. S. Department of Education, 2020b).

Defining the Gaps in STEM Fields

The shortfall of minority representation in STEM in the U.S. is evident in areas of workforce and educational attainment. The evidence of the skills gap derives from inequitable corporate climates, policies, and the lack of educational funding in inner-city schools. Resources for STEM education and workforce ventures, are not distributed evenly or equitably, particularly in schools and districts with high rates of poverty; therefore, the skills gap, which should be getting smaller, is still problematic.

Educational and Occupational Attainment-Gaps

Even though there is projected growth in STEM jobs, minority groups with lower educational attainment will not qualify for these positions because they will lack the required credentials or degree to pursue them. With gaps in post-secondary completion rates in STEM, too few underrepresented minorities can benefit from the anticipated growth STEM occupations.

It is the idea that higher education attainment leads to better job opportunities, but this is not always the case for minority groups—and for various reasons. Although reports and statistical analyses suggest that education makes a difference, it does not close the racial gaps in education or employment attainment (Grunewald, 2018), but unfortunately, it does decrease them.

The United States has a long and persistent history of racial and ethnic gaps in education and occupational attainment (NCES, 2019; U. S. Census Bureau, 2017). African Americans, Hispanics/Latinos, and Native Americans were being educated in solely segregated schools that were funded at much lower rates than predominantly White serving schools and were excluded from many higher education institutions as late as the 1960s. Though studies show racial and regional differences in educational resources, educational attainment, and economic outcomes had narrowed substantially since the early twentieth century (Goldin & Katz, 2007), national data and research continue to illustrate disproportions between minority groups and non-minority groups.

Educational Gaps

The National Center for Education Statistics (NCES, 2019) reported gaps in educational attainment between minority groups, including American Indian/Alaska Native, and Whites from 1940 to 2018 (NCES, 2019). Looking at a ten-year span of the data reported on high school completion rates by NCES from 2008 to 2018, the gaps between all racial and ethnic groups in the U.S. had a slight decrease of 3% but illustrated at least a 15% gap in attainment rates between minority groups and Whites. The gaps in high school completion rates between the following minority groups and their White peers are dramatic: African Americans/Blacks (7% gap); Hispanics (27% gap); American Indian/Alaska Native (11% gap); and Pacific Islanders (2% gap). The reported lags in high school completion rates among minority groups can also translate into gaps in higher education attainment rates. The average gap in higher education found between all ethnic minorities and Whites was 8%. When separating the gaps by race, the gaps averaged between 10% and 20%: African Americans (13% gap); Hispanics (20% gap); American Indians/Alaska Natives (18% gap); and Pacific Islanders (10%) (NCES, 2019).

Considering the history of education in the U.S., African Americans have made great strides over the last three decades in completing high school and attaining a bachelor's degree or higher. It wasn't until the early 1990s that both levels of educational attainment gaps between African Americans and Whites began to lessen by 10% (NCES, 2019). The attainment gaps between the two groups are also projected to somewhat decrease in the 21^{st} century (Reeves et al., 2016). Even so, African Americans continue to face challenges that impact their high school completion rates, which obviously reduces any notion of them attending college. These challenges are often a result of parental guidance and their low-level of educational attainment, low socio-economic backgrounds, impoverished schools with minimum funding and resources, and low expectations of success and educational attainment set by themselves and by non-minority teachers (Gershensonet al., 2015). Similar challenges can also be found in Hispanic communities, accompanied by literacy and language differences (Schhneider et al., 2006).

Compared to other underrepresented minority (URM) populations mentioned in this study, Hispanics had the largest gap in high school completion and degree attainment rates among racial and ethnic groups. The educational experience of Hispanics in the United States is one of accumulated burdens and disadvantages because most of them begin their educational journey with lesser economic and social resources than many other minority and non-minority groups (Gándara & Contreras, 2010; Schhneider et al., 2006). However, according to the data trends in NCES (2019) and research on various dimensions of poverty and race (Reeves et al., 2016), educational attainment gaps for Hispanics and African Americans are closing—but they will still have lower rates than their White counterparts.

Compared to their peers, American Indians and Alaska Natives (AI/AN) will not see the same growth in educational attainment (Wong, 2015). This is so because research suggests that the data trends of this particular minority group deviate from the general student population with the inclusion of all genders and racial and ethnic groups (Davis & Tassin, 2008; Wong, 2015). AI/ANs poor health literacy and health behavior and geographic isolation (Persaud-Sharma, & Burns 2018; Sarche & Spicer, 2008), which was impacted by the history of America's colonization practices, led to the destruction of AI/AN family structures (Association of American Medical Colleges, 2018) and their discrepancies in education and employment. Research indicates that most American Indians and Alaska Natives attend separate schools from the general population, which were found to be under-resourced, neglected, and unsafe (Persaud-Sharma, & Burns 2018; U.S. Government Publishing Office, 2015; Wong 2015). One study pointed out that the schools' curricula were custom-made to indigenous outlooks of the world and perceived learning needs (Wong, 2015). Because of American Indians' and Alaska Natives' earlier educational experience, their performance and completion rates are much lower than their peers when they enter the U.S. education systems. Therefore, as noted by the Postsecondary National Policy Institute (2019), American Indian and Alaska Native students will less likely be college ready because of their limited access to quality instruction or no access to college prep courses.

Asians exhibited high educational attainment rates in high school completion and degree completion. Though Pacific Islanders had a 3% gap in high school completion rates between those of Whites, the degree attainment gap was much higher at 10%. In a study published by the

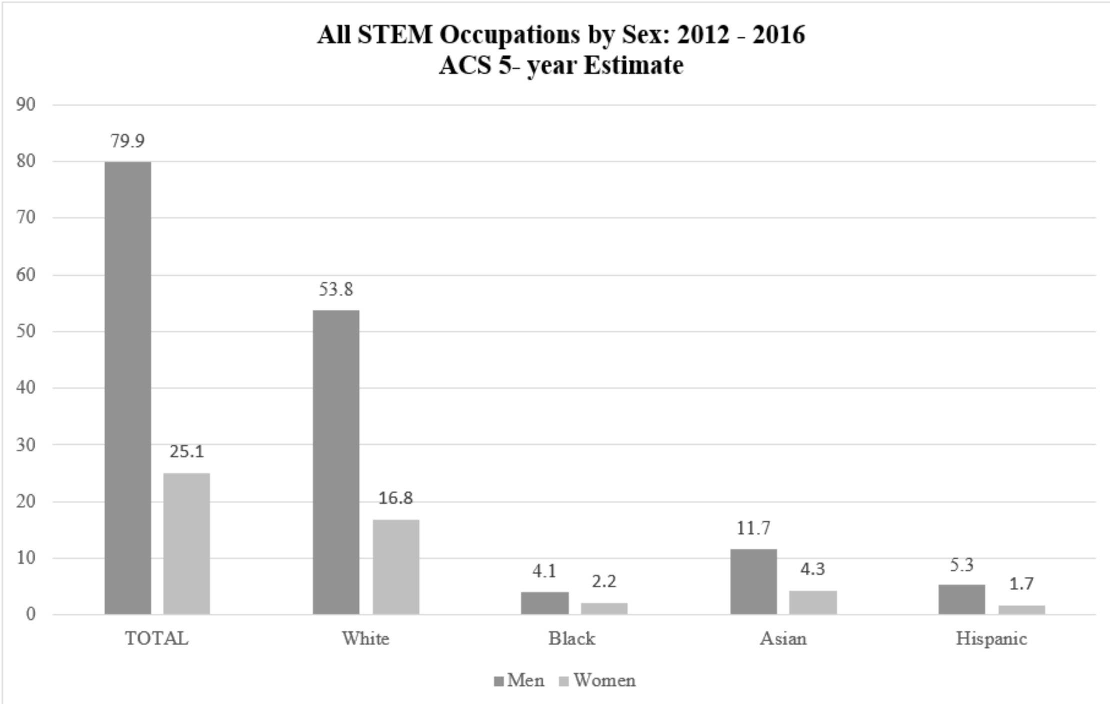
California Journal of Health Promotion, the severely low socio-economic conditions inspire Pacific Islanders to view education as a means to achieve a better quality of life (Sablan, 2015; Tran et al., 2010). The poor health status of the population has also been related to the higher educational gaps of the group (Edlagan & Vaghul, 2016) along with other factors similar to other minority groups, such as inequitable access and resources, parent/family-school participation and involvement (Kerr et al., 2018), and language differences (Edlagan & Vaghul, 2016; Tran et al., 2010). There was limited research on this particular group because of the limited availability of disaggregated data (Edlagan & Vaghul, 2016; Ngo & Sablan, 2019; Sablan, 2015). Sablan (2015) emphasizes that Pacific Islanders continue to be neglected in representation in educational research.

Education is a critical issue for all Americans. However, educational gaps and limited access to quality education have had a disproportionate impact on Pacific Islanders, American Indians, Alaska Natives, and African Americans\Blacks. It is the means to escaping or preventing poverty and obtaining gainful employment. Among other contributing factors, little or no education restricts lucrative employment opportunities, and there may be a huge employment gap between those who can find specific jobs, especially those in STEM fields because of their educational background and those who have not received appropriate education targeted for their career aspirations.

Employment Gaps

Due to the COVID-19 crisis, the overall unemployment rates within the U.S. are projected to soar well beyond the current unexpected rate of 4.4% (Trading Economics, n.d.). According to the U.S. Labor Force Statistics from the Current Population Survey from 2010-19, Whites had the second lowest unemployment average rate of 5.7%; Asians' unemployment rate was the lowest at 5%; Blacks/African Americans had second highest at 11.2%; and the unemployment rate for American Indian and Alaska Natives was 10.5%. While there are fewer gaps in the general unemployment rates between the racial and ethnic groups, the gaps in occupation attainment, particularly STEM occupations (computer and technology; mathematical science; engineering; life scientists; physical scientists; social scientists; and life, physical, and social science technicians) remain an ongoing imbalance between URMs and non-URMs. According to the five-year estimate American Community Survey (ACS) 2012-2016 results reported by the U.S. Census Bureau (2019), Whites and Asians were overrepresented in the STEM areas (Figure 1). The survey also showed the highest overrepresentation in STEM occupations with White males at 54% (U.S. Census Bureau, 2019). The second highest representation in the STEM professions were Asian males at 16%. Both genders of Hispanics and Blacks, and White females were underrepresented in most of the STEM areas (Figures 1 & 2) compared to their representation in the general workforce (U.S. Census Bureau, 2019). Black females (2.2%) and Hispanic females (1.7%) had the lowest representation in most STEM areas (Figure 1), with the exception of life scientists/medical occupations. Black males had the lowest representation (4%) among all racial/ethnic males in STEM occupations.

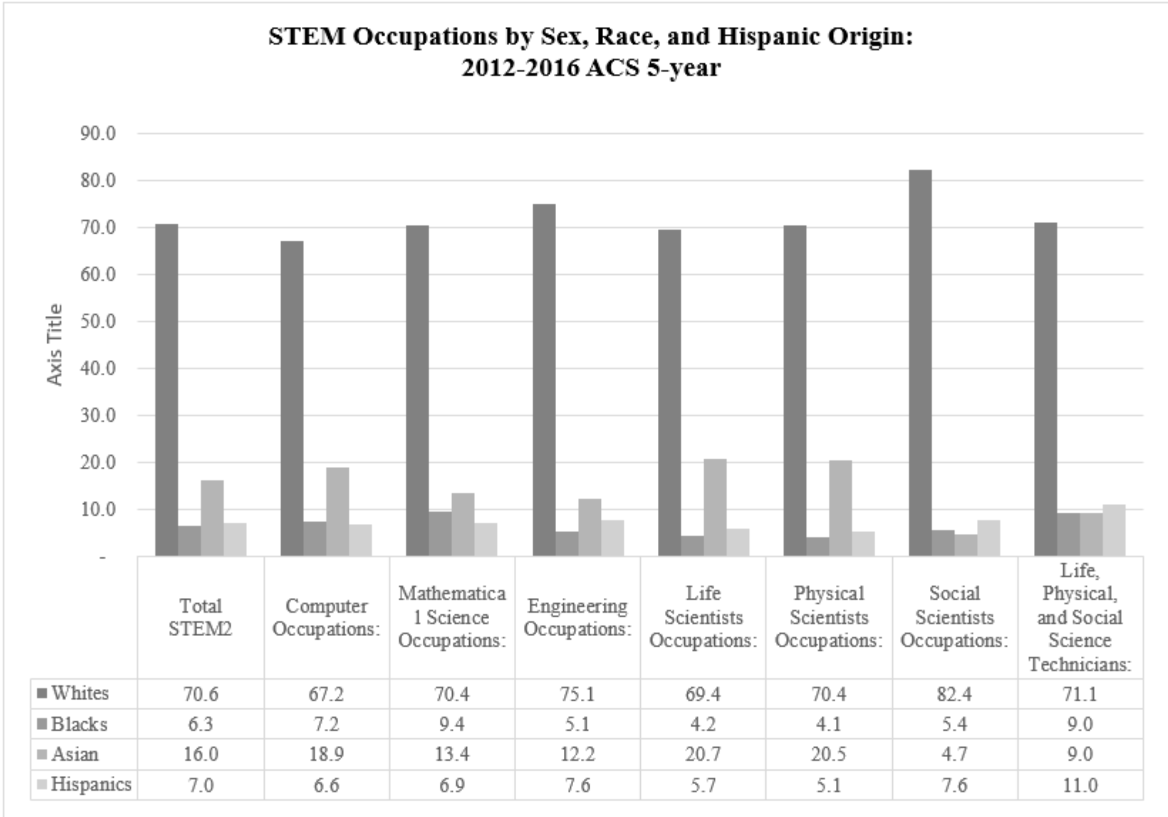
The gaps in STEM occupations were found to be associated with the gaps in educational attainment. As Fayer et al. (2017) asserted, STEM occupations will require technical training and/or a post-secondary degree; however, minorities face different roadblocks to education attainment that hinge their path to post-secondary associated with the gaps in educational attainment.



Source: U.S. Census Bureau (2019).

Figure 1. All STEM Occupations by Sex and Race

Oftentimes, low educational attainment or failure of high school completion affects career choices and the decision to pursue a high education. The identified gaps in educational and occupational attainment are relevant to this study because identifying disproportions in the education-to-employment pipeline is critical to effectively closing the STEM gaps in education and the workforce. Specific levels of education attainment and credentials are needed to pursue STEM occupations. In most instances, access to quality educational experiences start at home, but that is not always the reality for most underrepresented minorities because of challenges resulting from low socio-economic statuses and minimum to no educational experiences from parents. These circumstances can leave students unprepared to manage other disparities in education.



	Total STEM2	Computer Occupations:	Mathematica l Science Occupations:	Engineering Occupations:	Life Scientists Occupations:	Physical Scientists Occupations:	Social Scientists Occupations:	Life, Physical, and Social Science Technicians:
Whites	70.6	67.2	70.4	75.1	69.4	70.4	82.4	71.1
Blacks	6.3	7.2	9.4	5.1	4.2	4.1	5.4	9.0
Asian	16.0	18.9	13.4	12.2	20.7	20.5	4.7	9.0
Hispanics	7.0	6.6	6.9	7.6	5.7	5.1	7.6	11.0

Source: U.S. Census Bureau, 2012-2016 American Community Survey (ACS) 5-Year Estimates.

Figure 2. STEM Occupations by Race

Impact of K-12 Education Preparation

Understanding the history of the development of socio-cultural barriers and education for minorities is an integral part of understanding key factors such as the attitudes, perceptions, and priorities of underrepresented minorities in present time. These factors play a significant role in the academic success of minorities in the K-12 systems and at the post-secondary level. By 2050, key events, such as the Brown vs. the Board of Education legal case, will be very close to the 100-year anniversary, and yet there are still visible inequities in our K-12 educational systems we need to address. The trial of Brown vs. the Board of Education of 1954, the Elementary and Secondary Act (EASA) of 1965, or the No Child Left Behind Act (NCLB) of 2001 are all significant influences on the work that is continued presently (Barton & Cooley, 2010). In 2012, President Obama signed an executive order that created a White House Initiative on Educational Excellence for African Americans (U.S. Department of Education, 2012b). Even with the order, research and statistics continue to reveal an extensive gap in educational preparation and completion between minority students and their White counterparts. Numerous studies have shown minority students, particularly African Americans, Hispanics, and American Indians, continue to fall behind in standardized testing, including scores on both the American College Test (ACT) and Scholastic Aptitude Test (SAT) during K-12 academic years (Anderson, 2019; Mucherah, 2018; Reeves & Halikias, 2017). This disproportion leads to fewer opportunities for URMs to access quality educational experiences and/or attend nationally ranked programs (Reeves & Halikias, 2017; Rosales, 2018).

African American students, and other minority groups such as Hispanic students, exhibit a "greater academic risk" for the following reasons: they are most likely a first-generation student, they begin college unprepared academically, and they need financial assistance (Falcon, 2015; Postsecondary National Policy Institute, 2020). Also, these students will most likely have to juggle a full-time job and family responsibilities while going to school to assist the family with essential needs (Greene et al., 2008). While each of these indicators do influence the academic success of *some* minorities, there is a rise of African American middle-class families that also suffer gaps in education, despite not being a victim to under-funded, inner city schools.

With every new administration that occupies the White House, leadership in K-12 school districts adjusts to funding and policy changes. However, as a result of federal policy shifts, K-12 administrators have to deal, not only with changes at the national level, but also with changes at the state level. While some states have dedicated substantial funds to increasing STEM programs throughout elementary, middle, and high schools, there is still a lack of funding allocated to teacher training and teacher recruitment. For example, in 2018 the state of California approved a budget for a $6.1 billion increase for K-12 schools with $400 million dedicated to STEM educational programs and teacher recruitment. However, the money is not to be allocated for teacher training. Individual school districts must apply for additional grant funding (Jones, 2018).

Unfortunately, very few states are afforded substantial budgets dedicated to STEM education for their K-12 school districts. In certain geographic locations, some school districts are subjected to negative pre-K-12 experiences of classroom marginalization and poor resources. In reference to the constructivist theoretical work of Derrick Bell (1992), Howard (2008) raises the question, "Where is the plethora of research and funding opportunities to identify meaningful interventions for this group?" While their question was directly referencing the experiences of African American males, it applies to all underrepresented populations especially in terms of the resources available in K-12 education. A survey conducted by the National Student Clearinghouse found that only 6% of students from K-12 school districts with large URM populations and low economical levels are attaining less post-secondary credentials in STEM compared to districts with considerably wealthier and smaller URM populations that have up to 17% of their students that earn a STEM post-secondary credential. Lack of access, initiatives, and funding continue to contribute to the gap within STEM education in K-12 school districts (Gewertz, 2015).

Because of economical downfalls and political power shifts, funding for STEM educational programs will continue to fluctuate to support the projected growth of STEM occupations. Some Fortune 500 companies, such as Northrop Grumman, have made large funding contributions to support teachers and students to gain access to programs including the National Math and Science Initiative's College Readiness Program (Randazzo, 2017). There are other examples of Fortune 500 companies and government agencies investing in STEM enrichment programs in K-12 schools. These contributions are an investment on the country's STEM intellectual capital that can be most easily transformed into economic gain and to become a leader in STEM worldwide. STEM has the ability to advance markets and expand economic mobility. A nation's prosperity and security are no longer solely dependent upon its natural resources but instead they are dependent upon the intellectual capital of its populace.

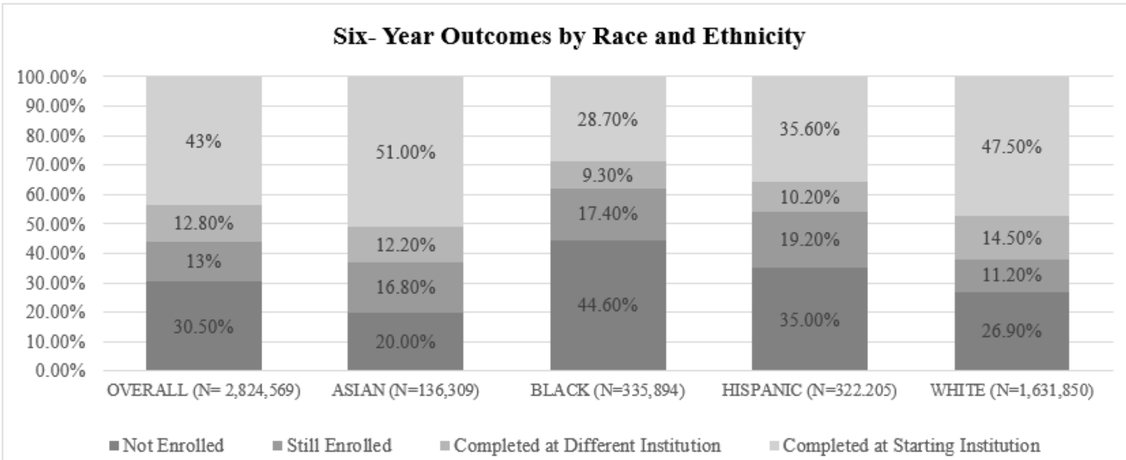
The educational gap is slowly closing. This progress could be a result of the national attention to initiatives and programs developed by teachers and administrators of K-12 school systems, such as the U.S. Department of Education's Federal TRiO programs (U.S. Department of Education, 2020a). These efforts correlate to positive outcomes for student success in higher education institutions, specifically community colleges, as the focus of student success among underrepresented student populations continues to be a national priority.

The Contribution of Community Colleges

Over the past few decades, there has been a shift in today's community colleges. With the increase in workforce development programs, community colleges are not only an opportunity for educational access for the community they serve but are also considered a major benefactor in their community's economic stability. However, accessibility and affordability have been, and continue to be, an earmark of the community college mission—especially among URM student populations. Community colleges have been challenged to prepare students to continue an academic career by completing a baccalaureate degree, or to prepare students for career fields in STEM that are in high demand and require ready-to-work skills for immediate entry into workforce. Community college administrators must continue to meet the needs of their changing population that are becoming more and more ethnically diverse with underrepresented students. In the future of student success and educational attainment of URM students in community colleges, what factors will be considered imperative? Will the same socioeconomically and historical events still be relevant, or will the historical events only be a part of history and the repercussions of those events be obsolete?

As authors Cohen et al. (2014) state in their book, *The American Community College,* "We don't stride boldly into the future. We back into it, dragging our history with us" (p. 435). One advantage that community colleges have is that they continue to be an accessible and affordable option for many prospective URM students (Brock & LeBlanc, 2005). Whether a student is entering post-secondary education directly from high school or perhaps returning to college after being in the workforce, community colleges provide a valuable educational environment.

Community colleges represent a pathway for obtaining a baccalaureate degree or they can provide training and skill development credentials for students who wish to enter the STEM workforce. Time and time again, reflection after reflection, minority undergraduate students provide constructive and positive feedback regarding their experiences at community colleges; however, there is still work to be done. Studies have shown that less than half of students entering community college with intentions of transferring and graduating from a four-year institution actually graduate from a four-year institution (Mooring & Mooring, 2015). Emily Tate (2017) states, "Students who started at community college and then continued their educations at a four-year public institution experienced very different outcomes, depending on race and ethnicity. After six years, about a quarter of Asian students and a fifth of White students had finished their degrees, compared to about a tenth of Hispanic students and one in 12 Black students" (n.p.). Figure 3 demonstrates the breakdown of degree progress and completion among Asian, Black, Hispanic and White students in fall 2010.



Source: Adapted from "Graduation Rates and Race," by Tate, E. (2017)

Figure 3: Graduation Rates and Race

URM student groups such as Asian Americans are often subjected to stereotypical behaviors from their fellow classmates as well as faculty. Asian American students are often excluded from policies and programs that focus on access for minority students, simply because they are perceived as students who do not need tutoring, financial services, financial literacy, or exposure to programs that serve the needs of other underrepresented student populations (Assalone & Fann, 2016).

With nearly half of the African American undergraduate students attending community colleges, the community colleges will continue to be critical to the educational access of underrepresented students (Wilson, 2014). Studies also identified that URMs are more likely to change from a STEM major to a non-STEM major. According to the National Science Foundation's National Center for Science and Engineering Statistics (2015), URM groups have a disproportionately smaller percentage of engineering and science degrees and jobs in the field of

STEM. The percentages are much smaller compared to Whites (Lin et al., 2018). Research found most minority groups are having paths outside STEM fields.

Community college leaders have been aware of this phenomenon for some time. The American Association of Community Colleges (2017) website demonstrates the need to focus on the student success of URM male students by initiating and encouraging institutions to implement programs to promote degree completion, provide support, and narrow the gap of educational attainment for minority males. These types of programs are going to be crucial to increasing the diversity of the STEM workforce and brain power of the United States (Clewell et al., 2006). The National Equity Atlas (2017) reports that minority males, a group that includes Black, Hispanic, Asian, and Native American populations, will make up 50% of the U.S. population by 2050 (National Equity Atlas, 2017). According to Cohen et. al (2014) community college leadership and faculty will be key instruments in creating innovative programs and incentives to narrow the gap of educational success among minority students in STEM.

In their article, *The Effort-Outcome Gap: Differences for African American and Hispanic Community College Student in Student Engagement and Academic Achievement*, the authors explore student engagement among minority students in community colleges. They define student engagement as the effort, in both time and energy, students commit to educationally purposeful activities and institutional conditions that would encourage students to participate in educational practices (Greene et al., 2008). This study also demonstrates how the African American and Hispanic student populations are more engaged in the community college they attend. However, there is still a concern with completion rates for these two underrepresented groups in all programs, including STEM areas. According to a report from Inside Higher Ed that reported outcomes from a report by the National Clearinghouse Research

Center, White and Asian students have similar outcomes of completions rates at 62% and 63.2% in fall 2010. The Black and Hispanic students had completion rates of 38% and 45.8% in the same time period (Tate, 2017). These decade-old statistics are still relevant because the gaps are still present today.

As the color lines of the U.S. population continue to blur, leadership of community colleges must continue to invest in the resources to assist underrepresented students succeed in educational attainment. Francisco Rodriguez (2015), chancellor of Los Angeles Community College, states “To be successful, presidents must understand and, in many ways, reflect the mission, demographics, and culture of institutions they lead” (p. 21). Because of affirmative action programs that are still active, higher education administration can still practice and develop programs to promote diversity, equity, and inclusion (Rodriguez, 2015).

One crucial area of investment is the representation of minority faculty and staff within the institution. The lack of representation of minority faculty and staff in higher education institutions, especially community colleges, is not especially surprising considering the racial and gender gaps in STEM. However, many community college systems have had the discussion, included statements in their strategic plan, and developed campus committees dedicated to improving diversity on their staff. In a 2016 article, Morse et al. questioned: “How many community colleges have actually made real progress in hiring minority faculty and staff?” Morse et al. (2016) stated that any effort to increase faculty diversity must be thoughtful and coordinated. Why is increasing the number of minority faculty and staff and community colleges still very relevant and important? How will the institution benefit in the efforts to increase mentorship opportunities for minority faculty and staff? One answer is very simple. Rodriguez (2015), a community college president, states, “Administrators of Color serve as mentors for faculty of Color on campus and guide, said faculty who are considering the administrative pathway. Faculty of color serve as mentors for students of color and provide encouragement for succeeding academically and facilitating their career aspirations" (p. 22). Students seeing themselves—their gender and their color—in their mentors can also help promote student success in STEM, as well as develop career identity (NASEM, 2019a).

Gender Gap

The gender gap is another challenge that appears to align with the skills gap in the STEM workforce (Funk & Parker, 2018). According to GPO's definition of underrepresented populations, women are also considered URMs, particularly in the STEM workforce (GPO, 2011). Although women's representation in the STEM workforce has increased over the past thirty years, this representation exists mainly in healthcare fields (Beede et al., 2011; U.S. Census Bureau, 2019); women still remain underrepresented in engineering and computer occupations (Bix, 2006). According to the data and research reported by the National Science Foundation Division of Science Resources Statistics (2017) and Funk and Parker (2018), women, Blacks, and Hispanics have been underrepresented in the STEM workforce and education over the past 30 years and continue to be underrepresented in the 21st century. Researchers found that URMs, including women, are less likely to major in a science or engineering program when they enroll in college and less likely to persist and complete in these STEM fields by the end of their college journey (Funk & Parker, 2018; Green and Sanderson, 2018; Toven-Lindsey et al., 2015). Referred to as the "leaking STEM pipeline," many categories of the population are underrepresented in STEM careers, but women, by far, make up a large portion of the underrepresentation (Ellis et al., 2016).

Barriers for women who pursue an educational credential or career in STEM are associated with widely held beliefs and “myths.” In her research, Dr. Jacquelyn Blakley (2016) summarized the research on gender perceptions of adolescent girls and boys pursuing careers in STEM fields and emphasizes that the barriers are established early in children’s lives. Hanson (2012) discusses four myths that are relevant to women in engineering; however, these apply to women pursuing careers in science, technology, and mathematics as well. The first myth is that from a young age, girls aren’t as interested in science as boys are. The second myth focuses on the educational interventions that are created to increase an interest in science and the perception that these activities are not as attractive to girls as they are to boys. The third myth claims that parental influence is stronger for boys in pursuing STEM careers than for girls.

Blakely (2016) continued the discussion around these myths and gender perceptions. She noted the effects of teacher-pupil communication, stressing that studies have shown that teachers tend to communicate more with girls. Also, when grades are compared between female and male students, females who receive a higher-than-average grade in STEM-focused areas are more apt to drop out than male students who may receive the same grade. Studies posit that one possible explanation for this effect is that female students tend to be more self-critical and easily discouraged (Blakely, 2016; Hanson, 2012).

The substantial differences among men and women entering the STEM workforce have been obvious for many years, even as STEM industries have dedicated numerous resources to “even the playing field” for women and educational programs have been created to bridge the gap with training opportunities. In 2011, women made up over half of the workforce in the United States economy yet were employed in less than 25% of the STEM workforce (Beede et al, 2011). Even with recognition of the gender gap in STEM fields and increased efforts to address this, Funk and Parker (2018) reported that, while the representation of women substantially increased since 1990 in many STEM careers, there had been a significant decrease in women pursuing careers related to computer science. In 2016, approximately 25% of the workforce in computer science occupations were women, but this was significantly less than the near 32% in 1990 (Funk & Parker, 2018). Other STEM career areas, such as engineering, had only a slight increase from 12% in 1990 to 14% in 2018 (Funk & Parker, 2018).

To think about the gender gap in the STEM workforce of this country, one may consider the "historical circumstances" (Kohlsted, 2006) that affected the educational opportunities that were open to women who wished to pursue advanced degrees in STEM. According to the research conducted by Ellis et al. (2016), 17% of women, compared to 32% of men, state their intention to enter a STEM field at the beginning of their collegiate career. Completion data shows that only 35% of the female students who declare a major in a STEM area actually complete the degree. This statistic demonstrates the significant barriers affecting women who seek post-secondary credentials in STEM.

At the foundation of many STEM educational programs is advanced mathematics study. The perceived difficulty and reputation of mathematics courses, such as Calculus, often dissuade students from pursuing degrees in a STEM area. However, data has shown that women are particularly dissuaded from courses such as Calculus at a 1.5 rate greater than men. According to a national survey, women reported that they do understand the material, yet many do not complete the coursework. This discrepancy may be contributed to lack of mathematical confidence, not mathematical ability (Ellis et al., 2016). In the history of the field of engineering, the image of women as engineers came with much resistance (Bix, 2006) and very few women were able to practice engineering in the early 1940s. Kohlsted noted (as cited in Deacon, 1997 and Rosenberg, 1982) that women often pursued the social sciences because there was less resistance to research and more opportunities for exploration specific to women, such as the psychology of sex differences, the intellectual and physical capacities of women, variations of gendered identities, and the sexuality of women.

Gender and Race

While minority and non-minority women are both identified as URMs in conversations about STEM, women of color (primarily African American women) have been identified as the "minority of the minority." In 2016, Fox Studios released a highly anticipated film about three African American women who not only changed the course of history for the United States, but also depicted the experiences of minority women in male-dominated, Euro-centric fields in the early 1960s. The film *Hidden Figures* was loosely based on the stories of Katherine (Goble) Johnson, Dorothy Vaughn, and Mary Jackson. Referred to as "human calculators," these three women were hired to perform calculations for the flight tests at NASA (Lee Shetterly, 2016). The popularity of the film reminded us again that the stories of these extraordinary women of color, and others like them, don't fill the history books and the majority of these stories and examples don't reach large audiences.

Faced with the possibility of multiple prejudices, minority women in STEM are still subject to the remnants of the "double bind" standard that was coined by the American Association of the Advancement of Science (AAAS) nearly 35 years ago (Malcolm et al., 1976). The "double bind," which refers to a woman of color being classified as minority in two categories, being in a male-dominated field and being in a white-dominated field, may not have the same adverse connotations today as in the mid-1970s; however, the term is still as real today.

Underrepresented women in STEM continue to face challenges related to equity in the workplace. Malcom (1976) states:

> The next-generation women, the Double Bind Daughters, face different challenges from those faced by their mothers; now it is less about rights versus wrongs and more about support versus neglect; less about the behavior of individuals and a culture that was accepting of bias as the 'natural order of things' and more about the responsibilities and action (or inaction) of institutions. (p. 163)

One could conclude, the progress of women in STEM are specifically linked to the identified cultural and social factors, including gender bias, stereotypes, and the climate of STEM workforce and STEM programs in colleges and universities. More than a few of these barriers, along with other socio-cultural barriers, also impact the general population of underrepresented minorities in STEM. In some limited STEM areas, there have been significant increases in the number of women represented, but unfortunately, within most areas, there has been very little to no improvement.

Statement of Problem

Since World War II and the first discussion of STEM as a defined career segment, women, African Americans, Hispanics\Latinos, and Alaska Natives or American Indians have been underrepresented in STEM occupations and academic programs (Wang & Degol, 2016; White, 2014). It wasn't until 1976 that Native Hawaiian or Pacific Islanders were defined as a unique racial group (U.S. Department of Education, 2012a), and since then, this group, too, has been recognized as an underrepresented population in the STEM workforce (Kerr et al., 2018). Since this time, the identified minority groups who are underrepresented in STEM are also increasing in percentage composition of the total population of the United States (Alika, 2012). That is, STEM is becoming even more dominated by white males. While efforts continue to address these gaps, some experts predict that, by 2025, the proportions of the minority groups in the United States will increase in STEM fields (Wang & Degol, 2016). The amount and degree of increase is not clear, however, as various factors have been found to be key determinants impacting the representation of the minorities in STEM degree programs and the workforce.

Community Colleges Respond

As dialogues continue to focus on the need to fill the skills gap in America's STEM workforce, workforce development leaders, particularly those in community colleges, are challenged to help resolve the growing problem (American Association for Community Colleges, 2017). Yet, filling the STEM skills gap is not the only challenge that workforce leaders face. Achieving the desired level of STEM workforce diversity and overcoming barriers to increasing the representation of minorities in STEM is a prevalent phenomenon and ongoing challenge for workforce leaders (Allen-Ramdial & Campbell, 2014), including community colleges (Cohen et al., 2014). Community colleges, which serve the majority of underrepresented populations in the United States, are perhaps the most well-positioned pathway to STEM within the American education systems. Community colleges have the opportunity to address the racial and gender gaps in STEM degree attainment and workforce. To tackle these challenges, community college leaders must ask the following questions: What is the skills gap in the STEM workforce? What are the barriers to increasing the representation of minorities in STEM degree programs and workforce? What can be done to mitigate barriers to increase the number of minorities in STEM degree programs and workforce?

Purpose of the Study

The purpose of this study was to define the skills gap in the STEM workforce and identify and mitigate barriers that contribute to the underrepresentation of minorities in this field.

The National Academies of Sciences, Engineering, & Medicine (2019a) and Toliver (2005) asserted that institutions and stakeholders at colleges and universities must first understand the problem and be more intentional and inclusive when serving URM students to help engage and retain them in STEM disciplines. Therefore, it is critical that institutions focus on strategies to overcome and mitigate barriers that impact the representation of minorities in STEM. The specific aim of this study was to investigate the skills gap in the STEM workforce, barriers that contribute to the underrepresentation of minorities, and best practices to recruit, persist, and retain minorities in STEM fields.

Significance of the Study

Understanding the skills gap in the STEM workforce and factors that contribute to the underrepresentation of minorities in STEM fields will help lead to changes in how education systems, industry, and other stakeholders prepare and work with underrepresented populations. Thus, this study could also help mitigate barriers that impact URMs' interest, persistence and retention, and obtaining employment in STEM fields. Research continues to depict the employment and education attainment gaps between URMs and non-URMs in STEM-related fields and statistically proves that as more URMs complete degrees and secure employment in STEM fields, the gap should continue to lessen. More research is needed to identify specific barriers to increasing the representation of minorities in the STEM workforce. Shrinking the racial and gender gaps in STEM will help promote innovation and increase production capacity, advance global competitiveness in STEM (Allen-Ramdial & Campbell, 2014), and improve economic mobility and income equality (Smeeding, 2016).

Research Questions

This study was guided by four research questions. One provided the context on the barriers to STEM faced by URMs, and the other three focused on strategies to mitigate three unique tiers of barriers. The research questions are as follows:

1. What are identified barriers to increasing the representation of URMs in STEM workforce and education?
2. What strategies can be used to successfully address individual barriers related to gender and race that limit URMs pursuing STEM careers?
3. What strategies can be used to successfully address environmental barriers related to URMs' family structure and societal influences that limits their interest in pursuing a STEM career?
4. What strategies can be used to successfully address the institution-based barriers that limit URMs' success in STEM majors?

The research method strategically amalgamated information from past and current research to identify barriers of URMs and strategies to mitigate those barriers to increase their representation in STEM education and the workforce. A study qualitative method was used to capture expressive information, such as experience and observations of URM barriers, and best practices to address these barriers. Using this method in research provided different perspectives and supplements the depth of understanding provided by quantitative and qualitative methods (Shorten & Smith, 2017). Approaching the study was method was critical to demonstrate the researchers' paradigm and experience of the research problem.

Delimitations

This study confined itself to interviewing and collecting data from those who served in roles that specifically focused on the development of underrepresented populations. Another delimitation was that we did not target one particular minority group but focused on underrepresented groups as a whole. The research and interview questions were also centered around the grouped population.

Definition of Terms

To diminish confusion or misunderstanding throughout this dissertation, the following terms are operationally defined:

Underrepresented Minorities (URMs): The term URM includes African Americans, American Indians/Alaska Natives, and Latinos, including women, who have historically comprised a minority of the U.S. population whose representation is lower than a given group (GPO, 2011; NSF, 2019)

STEM: STEM is a curriculum that has the basis of educating students within the four specified fields or disciples. The fields are Science, Technology, Engineering, and Mathematics (Gonzalez & Kuenzi, 2012). The disciplines are handled in an applied and interdisciplinary approach in the workforce.

STEM Workforce: Occupations that consist of or use science, technology, engineering, and mathematics.

Education Attainment: Educational attainment is a term commonly used by statisticians to refer to the highest degree of education an individual has completed as defined by the US Census Bureau Glossary.

Social and Cultural Barriers: Social and cultural barriers originate from social norms and cultural values. A socio-cultural barrier is a challenge related to the different groups of people in society and their way of living, traditions, and beliefs that can impact their success or quality of life (Bailey et al., 2014; Cambridge Dictionary)

Skills gap: The skills gap in this study will be defined as perceived skills deficit/shortage faced by employers.

Stakeholders: According to the glossary of Education Reform, the term stakeholders in education and as discussed to in this study, refers to any individual or group that is invested in the welfare and success of a school and its students, including parents, families, community members and leaders, industry, policymakers, etc.

Conclusion

Using the groundwork of qualitative research, this study sought to understand barriers of URM populations and the value of pertinent information that potential workforce and education leaders can practice. The contribution towards the mitigation of these barriers, provided by these specific stakeholders, can narrow the gap within workforce and educational practices as it relates to diversifying STEM. The results of this study may serve multiple stakeholders such as: community college leaders, K-12, industry, policymakers, and most importantly the URMs representation in STEM. Chapter II provides a summary of existing literature as it relates to the impact race, gender, and education on STEM; the impact of belief systems on STEM career aspirations; and strategies to mitigate the barriers.

Chapter II: Literature Review

Introduction

Over the past fifteen years, there has been extensive research on STEM and underrepresented populations, including studies related to URMs' barriers to STEM and practices to increase the visibility of URMs in STEM. This literature review discusses the impact of race, gender, and education on STEM, the impact of belief systems on STEM career aspirations, and strategies to increase the representation of URMs in STEM.

Impact of Race, Gender, and Education on STEM

Research focusing on individuals' characteristics and their decision to pursue a career in STEM has increased significantly. As reported by Clewell et al. (2006), in 1991 the National Science Foundation examined the impact of disparities that existed among specific racial and ethnic groups, gender, and education as means to improve diversity in science and engineering. Clewell et al. (2006) reported inadequacies in URMs' K-12 experiences and the impact they have on students entering higher education and pursuing a degree in STEM. A year later, a study by Tsui (2007) found that the disproportions of African Americans, Hispanics, and Native Americans in STEM fields were connected to a number of factors, including barriers that were of cultural and structural influences, that barred the entry of URMs into education. According to the study, these factors have negatively impacted the interest of URMs in obtaining a degree in a STEM field (Tsui, 2007). As studies increased examining factors that impact the representation of URMs in STEM, Beede et al. (2011) found that non-Hispanics, Whites, and Asians were more likely to have a bachelor's degree in STEM fields than any other racial or ethnic group. The researcher did not provide an explanation as to why non-Hispanics, Whites, and Asians were more likely to obtain a bachelor's degree in a STEM field. However, a study conducted by Weatherton et al. (2011) researched how the lack of support from schools and families can impact URMs' decision to pursue a degree, specifically a degree in STEM. Strayhorn et al. (2013) reported the under-preparedness of African Americans and Hispanics in collegiate STEM courses was a result of their K-12 experiences.

There is limited research reported on other URM groups in STEM, such as American Indians and Alaska Natives, Native Hawaiians, and Pacific Islanders. However, recent studies found that these particular groups are also impacted by similar barriers to STEM, such as limited access to quality educational experiences in K-12 because of low socioeconomic statuses (Kerr et al., 2018; Persaud-Sharma & Burns, 2018). NCES (2017) reported that only 4,366 bachelor's degrees were obtained in 2016 in science and engineering related fields by these two groups. The literature continued to show gaps in reporting related to American Indians and Alaska Natives, Native Hawaiians, and Pacific Islanders, including their educational attainment rates. Kerr et al. (2018) found that financial barriers often impacted Native Hawaiians and Pacific Islanders' decisions to enter college and enroll in STEM programs. Kerr and colleagues also examined the effects of geographical location and the lack of family support in interest in STEM. Persaud-Sharma & Burns (2018) discovered similar factors that impacted American Indians and Alaska Natives in STEM, including unmet psychological needs and poor health statuses. Their study also investigated the impact of American Indians and Alaska Natives' limited access to quality educational experiences on STEM.

Looking back at research that included the impact of gender on STEM, a few researchers (Allen-Ramdial & Campbell, 2014; Scott & Martin, 2014) found that URMs' educational experiences, including those of women, impacted their career trajectories in STEM. While the previous studies mentioned the impact of gender on STEM, Scott and Martin (2014) examined the mechanisms that impact women pursuing careers in STEM. Scott and Martin's study discovered that women's K-12 experiences and social barriers, similar to those of their male counterparts, also had an impact on their representation in STEM. Even though Scott and Martin (2014) identified women as having the least representation in STEM in the United States, NCES (2017) reported that underrepresented minority women received more associate's degrees in science and engineering than their male counterparts in 2016. However, the 2017 report also revealed a significant enrollment gap in science and engineering programs between women (23.5%) and men (76.5%) in 2016. To understand these gaps, Nix and Perez-Felkner (2019) investigated specific mechanisms, such as the impact of women's beliefs in their abilities in STEM fields. The research reported that women were more likely to have low confidence in their ability and performance in STEM than men. Eaton et al. (2020) reinforced these findings but also described how stereotypes and biases against women and URMs intersect with the impact of race, gender, and education on STEM, and subsequently impact an individual's belief systems on STEM.

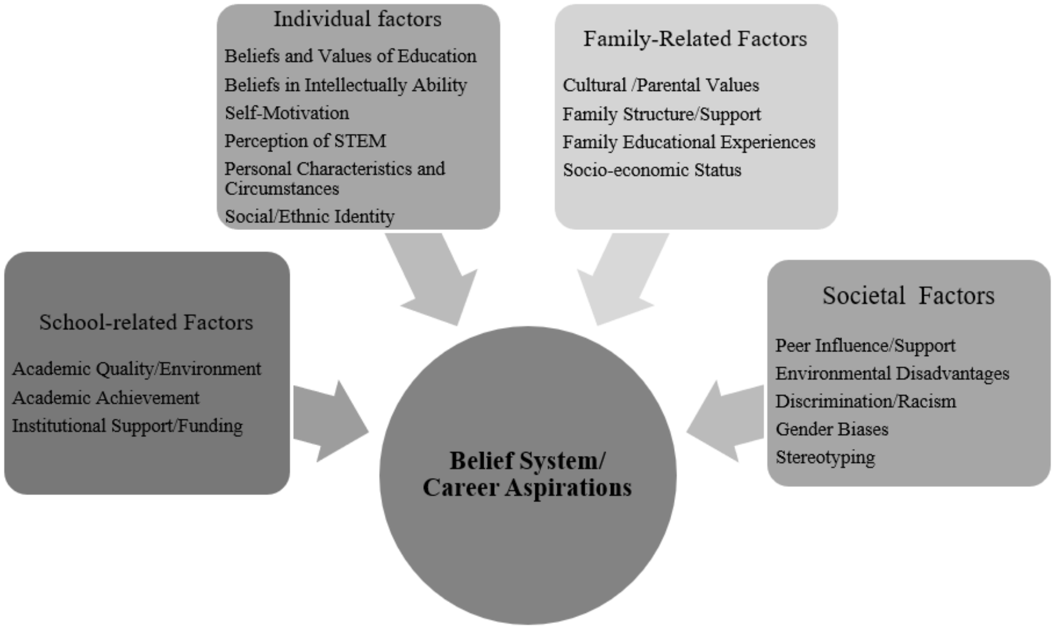
Impact of Belief Systems on STEM Career Aspirations

Several researchers have examined the impact of individuals' belief systems on STEM career aspirations. Weatherton et al. (2011) claimed students' ethnic backgrounds and retention in STEM fields were associated more with attitudes and perceptions than with deficiencies in intellect and capacity or to their academic credentials. Their study inspected the perceived barriers that prevented underrepresented populations from enrolling and successfully matriculating in the STEM area of engineering. To help understand the relationships between perceived barriers and the underrepresentation of URMs, including women, the researchers also analyzed a 2009 longitudinal study by National Center for Education Statistics. They found that, although policy innovations had been proposed to attract and retain students in STEM, it was equally important to understand the attitudes and beliefs of underrepresented populations and how social and cultural experiences affect STEM career aspirations. Alika (2012) studied the influence of social and cultural factors, such as peers and parental support, and their impact on career aspirations in STEM. Although the results from the 2012 study found that there was no substantial correlation between parental and peer group influence on individuals' career aspirations in engineering, the researcher discovered that the quality of the relationship with the two groups played a significant role in aiding or obstructing their career choice.

Scholars Wang and Degol (2013) and Scott and Martin (2014) indicated that individuals are less likely to translate their interests towards career aspirations when their efforts are impacted by adverse social and cultural factors. Wang and Degol (2013) linked social, cultural, and psychological factors to the differences in STEM interests and career choices among individuals and genders. Wang and Degol (2013) also noted that these factors are particularly noticeable in STEM areas, given that women, individuals of color, and first-generation students are underrepresented in STEM careers. Wang and Degol (2013) primarily focused on the influence of motivational characteristics, such as ability beliefs, gender-related biases and stereotypes, and mindset views, and their roles in limiting the representation of minority groups in STEM. Wang and Degol (2013) along with Grossman and Porche (2014) discovered that cultural and societal factors, such as environmental disadvantages, high ethnic minority and impoverished secondary schools, racial and gender bias, and poverty can create academic, behavioral, and psychological challenges among underrepresented populations. Scott and Martin

(2014) also explored the relationships between similar barriers and STEM aspirations. Both researchers discovered that despite of academic ability, students themselves perceived internal and external barriers to pursuing STEM programs in higher education. Later research supported these findings and claims of the aforementioned researchers. Henley and Roberts (2016) and Estrada et al. (2016) both reported that similar barriers stemming from social and culture factors obstruct belief systems that prevent or disrupt URMs career aspirations in STEM. Henley and Roberts (2016) and Estrada et al. (2016) accounted belief systems that originate from cultural and societal factors also significantly impact the career interests, if any, and academic preservation of minorities, along with their interests, performance, and persistence in STEM degree programs and careers.

Two years later, in 2018, researchers Lin et al. (2018) examined motivational characteristics and beliefs that were similar to Wang and Degol's research in 2013. Lin et al. (2018) referred to motivational beliefs as a set of propositions (e.g., interests, self-efficacy, expectancies, and values) that an individual believes to be right regardless of evidence and supporting facts. The researchers claimed that these beliefs are factual to an individual and influence their decision-making process to reach a certain target, including education and career attainment. Other studies conducted by Kerr et al. (2018) and Persaud-Sharman & Burns (2018) specifically point out how these factors also impact the career aspirations and belief systems of Native Hawaiians, Pacific Islanders, and Native Americans. The study by Destin et al. (2019) that included psychologist and researcher Carol Dweck found that these societal and cultural factors shape belief systems and form a fixed mindset in minorities, especially among African American, Hispanic, and American Indian populations from low-socioeconomic backgrounds. Studies by Nix and Perez-Felkner (2019) and Alonso (2019) supported research findings reported by Alika (2012), Wang and Degol (2013), and Destin et al. (2019). Nix and Perez-Felkner (2019) and Alonso (2019) summarized key aspects of societal and cultural factors that influenced motivational beliefs of underrepresented populations. These primary characteristics were also noted and summarized by Alika (2012), Wang and Degol (2013), and Isik et al. (2018). All researchers indicated that the motivational beliefs of URMs were found to be determined by different societies. Theses societies were defined as families, peer groups, schools, the community at large, and culture. According to the studies, families consist of various demographic factors, which are the level of family income, the level of education of the parents, the structure of the family, as well as the community characteristics (Alika, 2012; Alonso, 2019; Nix & Perez-Felkner, 2019; Wang & Degol, 2013). Each researcher proposed that families play a role in shaping and creating motivational beliefs of individuals or specific groups. In reviewing academic motivations, Isik et al. (2018) classified each influence into individual, family-related, school-related, and social factors. The classifications were intermittently noted throughout studies, such as Wang and Degol's (2013) theoretical model of career choices before Isik et al.'s (2018) study and have been modified in Figure 4 to include additional key factors identified in the literature that impact belief systems and career aspirations.



Source: Isik et al., 2018 Study, Factors Influencing Academic Motivation of Ethnic Minority Students: A Review.

Figure 4. Cultural and Societal Factors that Influence Belief Systems/Career Aspirations

Impact of Family's Educational Background

These motivational beliefs influence URMs' educational experiences in various settings. For example, several researchers have found that parents who have low-education levels are unable to provide adequate support to their children in the STEM fields. While Alika's (2012) research focused more on parental involvement, Wang and Degol's (2013) study focused on the education attainment of parents and its implications on an individual's belief system and career aspirations. Ceci and Williams (2010, as cited by Wang & Degol, 2013) reported that parental behaviors and beliefs about education reflect in different levels of socioeconomic or social classes and, in turn, influence the behavior and beliefs about education of their children. Greenman et al. (2011, as cited by Wang & Degol, 2013) also found that low-education families can affect the quality of educational experiences and interactions within the family. Alonso

(2019) pointed out that adequate family support can help cultivate self-efficacy, build self-confidence and expectations for success, which will in turn, encourage future career choices.

A few researchers have also reported that inadequate family/parental support, whether intentionally or not, can impact minority groups', including Pacific Islanders and American-Indians, academic interest and performance at the K-12 and post-secondary level. For example, Anyaka's (2017) study examined the income and educational attainment level of families and their influence on African American's belief systems and their motivation to persevere academically. The researchers discussed the importance of active family support, parental involvement, and communication to African American students' academic performance. Kerr et al. (2018) recognized that strong family obligations and traditional and/or religious restrictions hinder the professional ideals of Pacific Islanders and Native Hawaiians in STEM. The researchers explained how economic barriers to education impact generations of Pacific Islanders and Native Hawaiians.

The studies conducted by Wang and Degol (2013) and later reported by Alonso (2019) concluded that the factors shared by Kerr and her fellow researchers (2018) have the ability or potential to widen the gap in academic performance between students and people from different socioeconomic backgrounds. It also explained that because of beliefs and family structure, families may encourage more sons than daughters to pursue math and science careers. Wang and Degol (2013) described how these factors contribute to the gender gap in STEM because of the differences in expectations of career choices that families place on men and women in their families. While Wang and Degol (2013) reported potential threats in larger gaps between genders, Alonso's (2019) study proposed a much larger threat as a result of the barriers to STEM. The researcher projected that the factors threaten to widen the opportunity gap between the "haves" (the economically-advantaged) and the "have-nots" (the economically disadvantaged) in society regardless of gender identity.

Impact of Individual Factors

According to Maslow (1943), individuals' need for belonging must be attained before they can reach higher needs and desires of achievement. Sixty years later, researchers reiterated that before individuals can mobilize and motivate themselves to develop professional interests, these basic needs must be met.

Earlier in the literature, it was discussed that Alika's (2012) study focused on parental involvement. It also reported that active parental involvement contributed to an individual's ability to individualize and seek their own career aspirations (as cited by Middleton & Loughead, 1993). Wang and Degol (2013) reported similar indications and reported that individual experiences and characteristics, such as parental involvement and support along with other social and cultural factors, help shape the interests, task values, and self-efficacy of individuals. The researchers inferred that these factors also influence the decision of individuals to choose between STEM and non-STEM fields. Wang and Degol (2013) also reported URMs', including women's, beliefs about their own their intellectual ability also impacts their decisions to enter STEM fields. Brooks (2014) referred to the concept as the social cognitive career theory (SCCT). Brooks' (2014) study investigated the effectiveness of increasing math and science interests and self-efficacy and found that career interests and attitudes toward careers are heavily driven by self-efficacy or an individual's beliefs about their ability. Four years later, Lin et al. (2018) stated that individuals are able to make occupational and educational decisions or choices that are related and consistent in their interests and self-efficacy. Results of the 2018 study indicated that the beliefs and interests of the different people, especially minorities from disadvantaged upbringings, are dependent on their learning experiences, which are often a result of their socioeconomic status. In support of the findings reported by Lin et al. (2018), findings from another 2018 study by Isik et al. claim that the interests of underrepresented minorities from low-socioeconomic backgrounds and unfavorable experiences, shun or overlook STEM because they have little to no exposure and or support from family, peers, etc.

Earlier studies found that URMs, particularly African Americans and Latinos have difficulty with STEM coursework because of fear. Strayhorn et al.'s (2013) study revealed that minority students who have teachers of different races and ethnic backgrounds fail to ask questions in STEM courses because they fear they will be characterized as incompetent or unwise. Grossman and Porche (2014) reported students also feel inadequate in STEM fields when they are exposed to STEM-related discrimination or stereotyping. Grossman and Porche's (2014) study highlighted that these experiences in STEM led to students, both males and females, questioning their ability in these areas. Lin et al. (2018) reported that some URMs often perceive STEM fields/coursework to be difficult because they do not believe they have the ability or skills to pursue it. According to their study, the perception of difficulty is usually associated with fear and can increase doubts about their ability and deter their career interest and choice. The study also found minorities to have low confidence and low expectations of succeeding in the STEM field, which usually derived from cultural norms. The research defined culture as it relates to the implicit and explicit behaviors, customs, values, and norms that are normative with the described education systems. Lin et al. (2018) stated that underrepresented minority groups have cultures that are responsible for influencing their understanding of standards, expectations, and awareness as well as the feeling of belongingness.

However, some cultures inadvertently have negative impacts on an individual's interest, performance, and misconceptions about STEM. For example, a study conducted by Scott and Martin (2014) found that apart from racial barriers, women participants perceived many more internal barriers than males that made them reluctant to pursue STEM careers. The researchers defined the barriers as negative perceptions and stereotypes as psychological barriers (Scott & Martin, 2014). Other psychological barriers identified by Strayhorn et al. in 2014 were the feeling of isolation and invisibility in STEM fields, particularly among women and other minorities, such as African American and Latinos. The researchers mentioned that these feelings impacted the retention of underrepresented populations in STEM. Nix and Perez-Felkner (2019) reported that some women feel inadequate and are less likely to pursue STEM fields because they believe that such professions are meant to be for men, reflecting their feeling that women do not feel they belong. Alonso (2019) reported that students quickly exit the field of STEM if they do not feel a sense of belonging.

Natural Ability or Inherent Skill?

Building on past research, Metoyer and Gaither (2019) reported that sociocultural related factors are the belief that people believe that natural ability or inherent abilities are key determinants for an individual's intelligence and capacity for STEM learning and success. According to the study by researchers Muhs et al. (2012), African American and Hispanic women are perceived to be the most incompetent of all ethnic groups and genders, especially in classrooms. Researcher Alika (2012) reported that the STEM culture, which is apparent in most STEM-field classrooms, supports competition among students rather than active participation and collaboration; thus, in these settings, students from underrepresented backgrounds experience heightened feelings of inadequacy and the programs themselves have low expectations of them.

Malcolm and Feder (2016) identified that ability cues convey heavily in the workplace and classroom settings and reported that some professionals in the fields of STEM believe that success is attained based on natural talent and a certain level of intellect. Their study revealed that biases and negative race and gender stereotypes about individuals' abilities are particularly noticeable in STEM fields. These claims are very similar to the findings of Wang and Degol (2013) about the influence of social and cultural factors on belief systems and career aspirations. Eaton et al. (2020) reported prevalent perceptions remain holding that, for individuals to be successful in sciences and mathematics, they must possess natural talent and abilities. These perceptions, in turn, influence men's beliefs that women are less competent in STEM fields. The results of this study showed that biases and preconceptions affect perceptions of women and URMs in STEM and are contributing factors to their underrepresentation in the field.

Impact of External Environmental Factors

A few researchers found that microaggressions in external environments outside of an individual's home could also have an impact on career aspirations. Scholarly articles published by the American Psychological Association in 2007 define microaggressions as intentional and nonintentional behavior, comments, or statements that communicate negative messages and insults about or to nondominant groups, such as women and both men and women from underrepresented racial and ethnic groups in STEM fields (Sue et al, 2007). The researchers described the three types of microaggressions that are anchored in race, gender, and even in disabilities that have contributed to racial and gender discrimination, segregation, marginalization, and isolation in STEM fields: microassaults, microinsults, and microvalidations.

Yosso et al. (2009) identified microinsults and microvalidation as the most used forms of microaggressions used throughout classrooms and work environments. Alika’s 2012 study also supported these findings. Grossman and Porche (2014) discovered URMs' sense of belonging was found to be impacted by microaggressions and affected their decisions to pursue or remain in STEM fields at Predominantly White Institutions (PWIs), and even at non-PWI institutions. Although Malcolm and Feder (2016) reported that some instructors and peers maybe unaware that they are using microaggressions due to implicit biases that affect attitudes and behavior, recent research by Sue Capodilupo et al. (2018) showed that conscious and unconscious microaggressions have major impact on individuals, particularly minorities.

Studies have concluded that these forms of microaggressions have profound effects on URMs’ confidence, perception, beliefs about their ability, and sense of belonging in STEM. Dortch and Partel (2017) found there is not enough research that focuses on Black women and their sense of belonging in STEM; therefore, they explored how gender and racial microaggressions impacted Black women's sense of belonging in STEM at a PWI. The researchers also found that microaggressions that were encountered in a social and academic setting impacted the sense of belonging among the dual-minority group participants in the study. Harrison and Tanner (2018) also recognized that microaggressions in a classroom setting could impact an individual’s sense of belonging, self-efficacy, and STEM identity, especially if they are considered the minority within the classroom.

Strategies to Mitigate Barriers

Some studies suggest that an attainment of a higher level of education warrants multiple benefits to underrepresented populations, including higher income, social mobility, and gainful employment, and the economy (Blackwell & Pinder, 2014 as cited by Falcon, 2015). However, as various researchers have reported throughout the literature, underrepresented populations encounter obstacles to accessing higher education. While researchers have recognized more than a few barriers to STEM in underrepresented populations, the studies have also found that intentional strategies to mitigate these barriers must be institutionalized and integrated into the culture of the classrooms

Improving Educational Experiences

Weatherton et al. (2011) found implementing quality and multi-modal educational experiences in secondary and postsecondary coursework improves educational interests and outcomes. The quality of curriculum design and delivery was also identified by Strayhorn and his fellow researchers (2013) as means to improve educational experiences that have the potential to influence career aspirations. Eccles and her colleagues' report (as cited in Wang & Degol, 2013) that schools, teachers, and parents can create opportunities for students to engage in STEM-related activities through curricular experiences. Henley and Roberts (2016) supported this notion in their study by suggesting that more funding will help increase access to more STEM resources and high-quality STEM teachers, enhance educational experiences, and improve equitable school funding. Kerr and her research team (2018) also emphasized more funding is needed to support these efforts in impoverished and minority populated schools.

According to research, federal and local governments should consider allocating more funds and state appropriations to education systems to improve educational experiences, including teacher development in STEM (Kerr et al., 2018). Henley and Roberts (2016) and Kerr et al. (2018) both reported that more funding is needed in K-12 schools that are heavily populated with URMs from low socioeconomic backgrounds and the community colleges that will eventually serve them. Persaud-Sharma and Burns (2018) found that forming STEM training programs to engage and inform underserved populations would help improve educational experiences but financial barriers impede these efforts. Nix and Perez-Felkner (2019) suggested that education systems and policymakers need to rethink educational practices, advising, and mapping practices. Nix and Perez-Felkner (2019) also highlight the importance of elementary and high school teachers and counselors, as well as college advisors/coordinators and faculty, helping women and other URMs develop their beliefs about their ability and career aspirations throughout their K-12 and postsecondary journey.

Meeting Challenges of Environments

As reported earlier, several researchers (Metoyer & Gaither, 2019; Scott & Martin, 2014; Wang & Degol, 2013; Weatherton et al., 2011) have recognized that career aspirations and interests of URMs relating to their belief system are influenced by their environment, including family and cultural and societal factors. The researchers indicated that belief systems develop in adolescent years and into adulthood, which includes home and academic experiences from K-12 and college environments. In efforts to meet the challenges of academic environments, some studies highlight the significance of intentional engagement and the importance of partnerships when attempting to promote the representation of URMs in STEM. Grossman and Porche (2014) identified that exposing students to STEM during their K-12 years will help spark interest in STEM careers. The researchers also argued the need for interventions in environments that display microaggressions and biased behavior toward any specific gender or racial and ethnic group. Grossman and Porche (2014) highlighted the need for gender and race-based support in STEM, highlighting the importance of partnerships and community engagement. Other researchers, such as Allen-Ramdial and Campbell (2014), also acknowledged the need for colleges to develop intervention strategies to address challenges that students experienced in their early academic and home environments. Allen-Ramdial and Campbell (2014) proposed that institutions reshape their campus culture and climate to make it a pragmatic environment that substantially and fundamentally supports all students in their communities equally. Estrada and her colleagues (2016) argued that is the intent of increasing institutional accountability. They also mentioned that institutions should not receive support from federal and private funding agencies unless they are able to provide data-driven practices to increase awareness of institutional progress toward diversifying stem.

Henley and Roberts' (2016) research also communicated the need to provide financial and student support to populations from low-income families to help address or lessen financial challenges. Analogous to Grossman and Porche's (2014) discussions about involving URMs early in STEM, Kerr et al. (2018) also supported early engagement but believed engaging family in individuals' academic journey would also help parents understand the importance of STEM careers and STEM degree attainment. While Kerr et al. (2018) highlight family engagement, Nix and Perez-Felkner (2019) continue to focus on the need for intentional engagement from high school and college faculty and staff because families may not engage enough to have an impact on academic performance or belief systems.

Affecting Belief Systems

Researchers have examined and recommended shared strategies in their studies to address belief systems that influence career aspirational barriers of URMs. Weatherton et al. (2011) stated the obvious strategy in many studies, which is centered around deliberate engagement strategies. Grossman and Porche (2014) mentions student and parent early- and post-engagement initiatives can increase awareness about STEM. In fact, Grossman and Porche also suggested that teachers, counselors, and, when informed, families can help communicate the importance of STEM and encourage students to pursue the areas to offset inescapable racial/ethnic and gender stereotypes and biases. Although there are challenges to altering people's perceptions and implicit biases toward URMs, some researchers suggest strategies to address these behaviors and the impact they have on URMs. Wang and Degol (2013) reported the implications of stereotypes and biases and recommended growth-mindset strategies to deter the ramifications.

Researchers such as Weatherton et al. (2011) point out multipronged strategies to help address implicit bias and perceptions of all URMs, including women. The strategies they identified focused on the importance of building awareness around the problem and establishing partnerships and mentorship programs to help provide support to URMs. Scott and Martin (2014) echoed the strategy of providing URMs mentors, which included peers, faculty members, and career/professional mentors as a tactic to address psychological barriers and help shape career identities. Dweck et al. (2019) declared that belief systems can't totally be diminished, but they can be altered from a fixed minded set to a growth mindset. Alonso (2019) explained that altering belief systems can be done through practical and intentional engagement and intervention strategies and best practices that can also help URMs visualize and embrace what and who they can be in their own professional lives.

Summary

The literature is significant to this study because it provides primary sources foundational to the problem and identifies the challenges that should be addressed to resolving the problem. In all, the literature accentuated various possibilities that have impacted the representation of URMs in STEM fields, which in turn, demonstrated rippling effects and consequences from America's history that have shaped societal and cultural norms. These norms have led to low impacting educational experiences, such as inequities and limited access to quality education, for URMs that have been found to ultimately impact their education and employment attainment in STEM. While the data highlight the influence of educational experiences on degree and employment in these particular occupational areas, the literature also discusses how educational experiences of URMs and their parents influence their belief systems and career aspirations to pursue STEM careers. The presented contributing factors in the studies demonstrated how belief systems can influence career choice and have an impact on minorities' perception and experiences in STEM. The literature also identified strategies that community college leaders and other stakeholders could employ to become more intentional about how they serve and communicate with URM students to ensure persistence and retention in STEM. The data and research also revealed that minorities still face certain and substantial cultural and societal factors that affect their belief systems, including limited access to quality educational experiences because of their socioeconomic status.

Chapter III will reintroduce the research questions, design and methods, proposed stages of review, and the selection process of participants for this study. The methodology section will also describe the process used to identify common themes in barriers for URMs and the process the researchers applied to develop the Best Practices guide and strategies to mitigate those barriers.

Chapter III: Methodology

Introduction

The purpose of this chapter is to introduce the research methodology for this qualitative study that focused on identifying specific barriers impacting the representation of minorities in STEM education and workforce and best practices used to address and mitigate the barriers. This approach allowed for a deeper understanding of barriers to STEM and a better insight into the best practices and possibilities for increasing the number of URMs in STEM. The research design, interview participants, data analysis, and the process for constructing the best practices model are primary components of this chapter.

Research Design

The goal of this study is to identify barriers that limit URMs' pursuit of and success in STEM areas and present best practices for community colleges to alleviate those barriers in order to increase the number of URMs in STEM. This research study used interviews with experts in the field of higher education, workforce, and non-profit organizations working with underrepresented populations to support identified elements from the literature. Interviews added credibility and depth (Patterson, 2013) to the research and identified best practices for addressing the identified barriers within STEM education and STEM workforce. A purposive sample method was employed to identify participants to interview. The in-depth, one-on-one interviews highlighted the cynosure of the experiences of professionals that have contributed to STEM education and workforce development for URM student populations through innovation, exposure, and creativity.

Research Questions

The framework for the study was based on this guiding goal: to identify strategies that can be used to address the barriers caused by individuals' belief system on their career aspirations. These specific research questions provided the framework for the interviews and the resulting best practices:

- RQ1: What are identified barriers to increasing the representation of URMs in STEM workforce and education?
- RQ2: What strategies can be used to successfully address individual barriers related to gender and race that limit URMs pursuing STEM careers?
- RQ3: What strategies can be used to successfully address environmental barriers related to URMs' family structure and societal influences that limit their interest in pursuing a STEM career?
- RQ4: What strategies can be used to successfully address the institution-based barriers that limit URMs' success in STEM majors?

The interview questions used in this study focused on collecting participants' thoughts and observations about challenges and successes when attacking barriers encountered by underserved populations. The open-ended conversations were focused on these central interview questions:

1. What have you identified as barriers to academic success in regard to STEM education and the workforce in the minority populations you serve?
    - Have you observed any self-inflicted barriers in minority populations in the STEM workforce and education?
    - What limitations, if any, does your organization face in serving minority populations with these barriers?
2. What specific activities or practices have you implemented to mitigate barriers in minority populations in the STEM workforce and education?
    - What do you consider the most successful strategy that you and/or your organization have employed to mitigate those barriers?
    - How has it impacted the outcome of the minority groups you served?

3. What collaborations and community resources do you use that contribute to your organization in helping mitigate the barriers of the minority populations you serve?
4. What primary reasons have you seen for lack of student preparation for STEM programs?
    - If applicable, what student persistence issues with respect to secondary and postsecondary education experience have you identified?

Interview Participants

Employing a purposive sampling strategy allowed the researchers to select participants who currently have roles focusing on underrepresented populations in the STEM workforce and education. The participants were identified from the recent literature and/or through recommendations or personal contacts directly engaged in STEM education and workforce development of URMs. Each participant was known to be a stakeholder in higher education, workforce, or a nonprofit (501c3) organization. Approximately nine individuals were invited to participate in this study from across the U.S. The following five participants responded and accepted the invitation to participate (Table 1).

Table 1. Study Participants

PARTICIPANT'S NAME	TITLE
Participant 1 (P1) Commissioner Aaron Demerson w/ Commissioner Julian Alvarez III	Texas Workforce Commission
Participant 2 (P2) Dr. Chenchutta Jackson	Faculty, College of Computer Science and Computer Information Technology *Volunteer State Community*
Participant 3 (P3) Dr. Earnest Davis	Executive Director/President *North Alabama Center for Educational Excellence*
Participant 4 (P4) Dr. James Hicks	Program Director, Directorate for Education & Human Resources *NSF Division of Human Resource Development Louis Stokes Alliance for Minority Participation*
Participant 5 (P5) Anonymous Participant	Director of Diversity and Inclusion (Research Intensive four-year University)

Interview Process

Once the participants responded and agreed to participate in the study, the researchers contacted the participants to explain the interview process and provided a brief synopsis of the research study. Following the phone discussion, the researchers emailed the participants to establish a date, time, and a preferred modality of the interview.

Before asking the interview questions, the researchers provided an overview of the consent form, reiterating the confidentiality agreement and expectations for the interview to the subjects. Participants provided verbal consent to record the interview and use their name and organization / institution name in the study. All but one of the participants granted the researchers permission to use their name and organization in the study. Researchers then received verbal confirmation of the participants' agreement with the study parameters. The participants were afforded the opportunity to ask any questions and express any concerns before the start of the interview.

Each interview participant was asked the same set of interview questions to establish trustworthiness and ensure creditability of the research study. The participants' responses may have addressed a singular question or provided a more in-depth discussion. Based on the responses of the participants, the researchers may have included follow-up or probing questions to gain additional insight or clarification. Because the interviews were semi-structured and questions were open-ended, the researchers encouraged the participants to express their insights gained from personal and professional experiences. According to Singer and Couper (2017), open-ended questions may yield important insights on a specific topic and help the researchers capture a variety of possible responses. The semi-structured interview and open-ended questions allowed for some flexibility in the interview process and contributed an in-depth and rich narrative of the participant's knowledge and experiences (Seidman, 2013).

Each interview was recorded using the online meeting software Zoom and transcribed using the Zoom transcribing feature. The recordings were later submitted to a third-party transcription service, Scribie, to provide an accurate transcription of the interviews. After collecting and summarizing the interview information, in order to ensure credibility, unedited copies of the transcript and interview summary were sent to the individual interviewees to verify the accuracy of their personal transcripts and synopses.

Thematic Analysis of Interviews

The main purpose of this research is to understand the barriers and best practices of STEM in order to increase the number of URMs in STEM education and the workforce. In terms of providing services to underrepresented populations in STEM (whether in education systems or workforce), experiences shared by the interviewees added insight to the research questions raised in the study. By reviewing the transcriptions, listening to the recordings, and analyzing the experience of the participants, valuable information from institutional, community, state, and national levels was obtained about the strategies used to tackle specific barriers. While the participants served underrepresented populations in different capacities, common themes of barriers and strategies emerged from the analysis. The emergent themes from the analysis of the interviews are presented following the interview summaries in Chapter IV.

In focusing on the narratives, the core themes were created to describe the participants' experiences in serving URM populations coupled with their observations of barriers to STEM and strategies to offset these impediments. Ryan and Bernard (2003) pointed out that theme identification is considered to be one of the most critical tasks in qualitative research, which can help researchers add meaning to data and provide clear descriptions in the findings or report.

Each participant answered the interview and questions, including clarifying questions. Responses between each participant were consistent with one another, which supported the findings. As mentioned, the interview questions and themes derived from the following research questions:

- **RQ1**: What are identified barriers to increasing the representation of URMs in STEM workforce and education? (supported by interview questions 1, 1a, 1b)
- **RQ2**: What strategies can be used to successfully address individual barriers related to gender and race that limit URMs pursuing STEM careers? (supported by interview questions 2, 2a, and 2b)
- **RQ3**: What strategies can be used to successfully address environmental barriers related to URMs' family structure and societal influences that limits their interest in pursuing a STEM career? (supported by interview questions 2, 2a, 2b, and 3)
- **RQ4**: What strategies can be used to successfully address the institution-based barriers that limit URMs' success in STEM majors? (supported by interview questions 4 and 4a)

Each participant may have addressed the questions and themes either explicitly or implicitly. The discussion in Chapter IV includes quotations from the participants to deepen the understanding of the emotional context and thought process of the participant. According to Corden and Sainsbury (2006), sharing direct quotations can also enhance readability. Each interview was unique because of the different roles of the participants and their experiences in serving URM populations in STEM; however, the participants' responses presented themes that were consistent with each other and the literature in Chapter II.

Limitations and Delimitations

Because the researchers identified the participants through personal contacts and familiar literature, the majority of the interview participants, by happenstance, were located in the Southern region of the U.S. This could be considered a limitation because the experiences of URM populations in STEM education and research may be different in other regions of the United States. Cultural, economic, and societal barriers may range among various URM populations across the U.S.

Another identified limitation is that this type of research depends on the current roles of participants and their noted best practices implemented to serve URMs in STEM. As one participant pointed out, institutional services may vary depending on the population or demographics served. Because all services are not applicable to all URMs in STEM, there is no guarantee that similar results would be obtained from other organizations.

As a part of the interviews, the researchers intentionally did not include the perspective of an industry leader of a STEM company or organization. While the perspective of an industry leader would be a valuable contribution to the research study, the focus of industry does not fit into the ideology of those individuals that were specifically chosen to identify and provide solutions to mitigating the barriers of URMs with STEM areas. Although industry leaders were strongly considered, the researchers ultimately decided that it would alter the focus of the research and interview questions and could possibly change the intended direction of the study.

This study focused on using participants in roles serving URM groups and underrepresented ethnic minorities, without providing focus on any one specific minority group. Also, while the study could have multiple participants, it had a limited number of participants. Additionally, it is assumed that all participants that were involved in the study provided accurate answers, and respondents felt confident and successful in providing services to the URM population.

Construction of the Best Practices Model

In constructing the best practices model for this study (contained in Chapter V), the narrative and the themes from the study were considered. Lewin's (1946) three-step planning model (Figure 5) provides an approach to change that can help address the barriers that URMs often encounter that disrupt their interest and retainment in STEM. Therefore, the best practice model was structured with a focus on overcoming individual, external, and institutional-based barriers. According to Lewin's (1946) theory, change begins with recognizing the factors of influences that impede positive change in a system or within an organization. In applying this model, community colleges were identified as "the system" in this study. Lewin proposed that change cannot take place by simply changing the behavior of an individual, but requires understanding the "why" and a larger shift within groups, organizations, or systems. Thus, in this study, understanding the reason for barriers of URMs is imperative to developing well-informed strategies or best practices.

Unfreezing = Evaluating and Diagnosing → **Change** = Planning and Taking Action → **Freezing** = Reinforcing Change

Figure 5: Lewin's Action Research Model

The initial steps in the Unfreezing process include (1) Evaluating: Collecting data about the state of the problem. This step also includes creating awareness about the problem. (2) Diagnosing: Using knowledge attained about the specific problem and knowledge what has worked in the past to identify barriers and opportunities to improve; and (3) Plan: Create a comprehensive plan based on the knowledge gained prior to Action.

Lewin's steps to change have been noted to be successful in change management for nearly 50 years (Cummings, Bridgman, & Brown (2016). In 2016, Estrada et al. utilized Lewin's model to improve underrepresented minority students' persistence in STEM (see Figure 6). The model has been modified to construct the best practices model in addressing barriers influenced by individual, external, and institutional factors identified in this study.

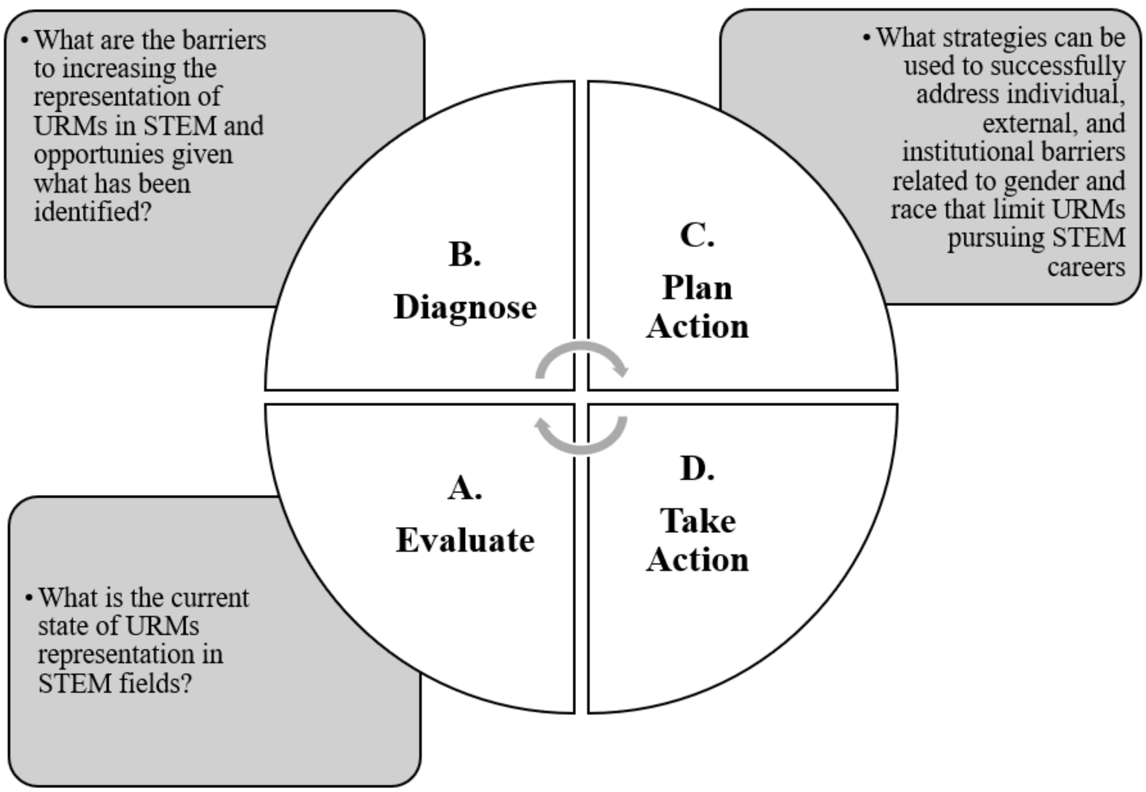


Figure 6. Model to Implement Change. (Adapted from Estrada et al., 2016.).

Conclusion

Because of perceptible educational and occupational gaps in STEM between URMs and non-URMs and the need for a robust and diverse STEM workforce, community colleges need to implement changes within the STEM pipeline that would help mitigate these gaps. Barriers to increasing the number of URMs in STEM require attention and must be recognized and addressed with intentionality and comprehensive strategies to address them. The findings supported by this study will help industries, community college leaders, and other stakeholders of workforce development find common ground to address the factors that contribute to the underrepresentation of minorities in the STEM workforce.

Chapter IV: Results and Analysis

Introduction

This chapter provides a summary of the interviews with five experts who currently have roles focusing on underrepresented populations in the STEM workforce and education. These interviews identified significant barriers to URM success in pursuing STEM education and careers. Following the interviews, a thematic analysis of the interviews examines these barriers and the strategies applied by the professionals and their organizations.

Summary of Interviews

Interview 1: Commissioners Demerson and Alvarez

Commissioner Aaron Demerson of the Texas Workforce Commission provided a brief description of his role and the role of his colleagues in serving URMs in STEM and the Texas workforce. Commissioner Demerson explained that he represents about 565,000 employers and 2.6 million small businesses in the state of Texas and advocates on their behalf as it relates to success in the state. At the beginning of the interview, the researchers were introduced to Demerson's colleague, Commissioner Julian Alvarez, who also provided his verbal consent to record and share his information and portion of the interview. As Demerson described, Alvarez represents the employees of the state, who also provided his insights on the barriers of URM populations in STEM and the workforce. Commissioner Demerson also mentioned another colleague who represents the public. That colleague was not present during the interview. Demerson acknowledged that they were all appointed directly by the governor of Texas to serve in the roles to ensure a holistic approach in developing a robust and skilled workforce, including STEM, through several initiatives.

The interview was led with a brief discussion with Commissioner Alvarez about URM barriers in STEM. Alvarez acknowledged that he was a first-generation student and had parents with limited education. He further explained that students, particularly Latinos/Hispanics and African Americans who come from low socioeconomic backgrounds and who have parents with limited educational experience, are often blocked or less exposed to quality educational experiences. Alvarez briefly discussed the digital divide as a barrier among this particular group of people.

Commissioner Demerson echoed similar barriers throughout the interview along with many others, such as health issues that prevent regular attendance in school, limited transportation, and limited awareness about STEM. The commissioner pointed out that the different populations of Texas, particularly the minority population on the lower spectrum, may be impacted more in terms of health and financial issues and access to quality resources. Throughout the interview, he also recognized the lack of access to technology as a barrier. Demerson referred to Alvarez's comments about the digital divide between impoverished and non-impoverished neighborhoods and school districts. He further explained that underserved minorities in these areas may not have access to computers/laptops or internet capabilities. He shared a discussion that the Federal Reserve System (FRS) had about the digital divide earlier in 2020 after schools had to completely transition to remote services/online courses because of the COVID-19 pandemic. The FRS is the central bank of the United States and performs functions to promote the operation of the U.S. economy and conducts the nation's financial policy to promote maximum employment and the public interest (The Federal Reserve, 2020). Demerson mentioned the FRS conversation focused on the lack of education of some parents and their limited experience in technology and how these impact children who are now forced to complete school online. He said the purpose for discussion was to raise awareness of the digital divide, including among employers, and to identify ways to educate parents and place resources to bridge the digital divide.

The commissioner also noted that the low expectation from parents, an individual's low self-confidence, peer pressures, and the belief that STEM is a difficult and harder path to success were also barriers to STEM. He credits these beliefs to basically, "not knowing." Demerson claims the lack of knowledge and awareness impacts students' perception of STEM, especially if they haven't been exposed to the areas. He commented, "It is similar to when someone says, 'I don't like math,' or 'I don't like golf.' But they never played it."

Demerson indicated that these barriers do not apply only to STEM but can impact the path to education, career, and everyday life for individuals. He expressed that he doesn't see limitations in addressing these barriers; however, he does believe there are limitless opportunities. To promote URMs in STEM and to address these barriers, Commissioner Demerson suggested that exposure to STEM should start at the early stage of learning in childhood education, and the right people must be in place to do so.

To meet needs of the Texas workforce, including STEM areas, Demerson identified several agencies and workforce services that assist in these efforts. He clarified that the Texas Workforce Commission works with 28 local Workforce Boards to deliver workforce preparation services and solutions to surrounding communities as they relate to the minority population in STEM. As he described, a number of programs are targeted toward individuals who are looking at STEM opportunities, no matter what their needs are. Demerson discussed and described the following services and initiatives in the interview:

- **The Texas Department of Assistive and Rehabilitative Services** (DARS) program provides services that assist in preparing youth and students, including those with disabilities, for post-secondary education and employment opportunities. The program collaborates with community colleges, family, high schools, and/or the Educational Service Center.

- **Texas Reality Check** is a Texas-based tool that teaches families about financial literacy and provides valuable information on industries and careers. The commissioner mentioned that the tool can be used by students, counselors, parents, grandparents, and anyone outside of Texas.

- **Jobs Y'ALL** is also a Texas web-based tool designed to help individuals explore careers and internships in Texas-focused industries, such as advanced technologies and manufacturing, life sciences, health care, information and computer technology, energy, and aerospace.

- **Self-Sufficiency Fund**: The primary goal of the program is to provide training grants for industry recognized certificates and credentials and to help individuals establish a career path toward higher-level occupations, particularly in STEM and advanced manufacturing-related careers. Demerson described the program as being efficient for businesses and integrates and teaches technology to non-tech employees, such as hospitality/hotel employees.

- **Skills Development Fund Program** is a $25 million-dollar program that includes collaboration with community and technical colleges, industries, such as the Toyota Plant and Rackspace in San Antonio, Samsung in Austin, and many more businesses to provide local customized training opportunities and workers to increase skill levels in the Texas Workforce.

- **Code the Town**: A 2014 initiative that targeted Hispanic 5th grade students in Mission, TX, also known as the Valley part of Texas (close to the Mexico border), to help them reach their full potential and introducing them to STEM by teaching them coding skills and enhancing their digital literacy. According to Demerson and Alvarez, the initiative provides students and teachers with knowledge in the specialized technology skills.

Of the programs and initiatives discussed, both Commissioner Demerson and Alvarez raved about and highlighted the *Code the Town* initiative and its impact on the students, which was under Demerson's leadership. Commissioner Demerson said that the program was significant because they had taught more than 400 young Latinos/Hispanic youths who could barely speak English and have never experienced coding. Both Commissioners reported that the students produced over 2,600 apps at the end of the program and expressed that it demonstrated that students, regardless of their background, could be taught STEM when given the opportunity. In 2015, President Barack Obama commended the efforts and remarkable results of the program.

Towards the end of the interview, Demerson suggested that the Workforce Commission could help narrow the gap through initiatives such as Code the Town. The commissioner also suggested that there should be better marketing strategies to raise awareness of the needs of minority students and ensure that minority communities have access to information about similar programs. He stressed the importance of being intentional about services and assessing workforce needs to meet them effectively. As he reiterated, services will need the right elements and the right people to drive change. Commissioner Demerson later recapitulated the purpose of his role at the local level, which includes connecting the three key areas — workforce, economic development, and education — to produce skilled workers and fill gaps in the Texas Workforce, including STEM. Demerson closed the interview with the statement that was made by former president, George W. Bush in 2000: “Here we are, the world’s leading economy and leader in technology and innovation, creating the jobs of the future, but we’re not preparing our own children to fill them” (Burd, 2000).

Following the statement, the commissioner communicated that although progress is being made, it is not enough progress to address these gaps because the same issues are being discussed, 18 years later, in 2020. Demerson added that the world is constantly changing but posed the questions, “How can you keep up?” and “What do we do to keep up?”

Interview 2: Dr. Jackson

Dr. Chenchutta Jackson's jovial demeanor was immediately apparent from the beginning of the interview, as she gave her educational background and current professional position as a faculty member at Volunteer State Community College (TN). Dr. Jackson stated:

> I have also been involved in many research projects that… include the STEM field, as well as STEAM applications as well. So, as I said before, I have been in computer science since the late '90s and so now it's constantly contributing and learning the background and trying to encourage more minorities to get involved with STEM, and particularly, computer science and computer information sciences and systems, as well as computer information technology.

Dr. Jackson, who is originally from rural Mississippi, gave the interviewer insight into her undergraduate educational experiences as they relate to how she influences and motivates students in her own classroom. She credited much of her undergraduate success to her mentor, an African American woman, who encouraged her to pursue Computer Science (CS) and Computer Information Technology (CIT) and obtain a terminal degree in Computer Science Technology. Because of these experiences, Dr. Jackson outlined how her role as a faculty member serves minority populations in STEM education and employment attainment. While she recognized that the institution has a responsibility to encourage diversity within its student population, she also felt as though it's her personal responsibility to take charge and actively recruit and expose underrepresented student populations to computer science and computer engineering. From her vantage point, she expressed her feelings toward having a much larger role in mitigating barriers for URMs and accepted responsibility to personally take charge to advance the knowledge, as well as the field. In reference to her responsibility, Dr. Jackson stated, "And in order to make a better society, or a better product, or a better future, even at present, we need to have diversity within the field… So, it is my duty, as I said, having a Ph.D. in computer science, you see the lack [of diversity], you try to do something about it."

Jackson also described her experiences in confronting the barriers of academic success among URM populations. She explained that, while the number of URM students enrolling in Computer Science or the CIT field may be increasing, many of the URM students who major in the field or show interest often feel left out of the conversation or aren't given any career direction. Dr. Jackson referred to her own educational experiences. As a result of her attending a Historically Black College/University (HBCU), she didn't realize how few women of color were in the Computer Science field. It wasn't until she was seeking her Ph.D. at a Predominately White Institution (PWI) that she began to witness the gap and experience the disparity of URMs in STEM-starting with education and continuing into professional careers.

In regard to the self-inflicted barriers among URM students in STEM, Dr. Jackson described situations where URM students seek a career in Computer Science or Computer Engineering because they're excited about future opportunities — they want to be there — but they become immediately discouraged and try to blend into the background, or as she referred to it, as take a back seat.

In her position, she encourages underrepresented students to build confidence and reassures them that they are fully capable and belong in the program, especially the women who are pursuing the field. The researchers followed up with a question pertaining to confidence, or lack of confidence as a self-inflicting barrier. Dr. Jackson explained that many students that she encountered begin feeling confident but notices that the excitement seems to wear off and self-doubt seeps in. She compared the feelings of inadequacy and the lack of confidence to the well-publicized "imposter syndrome." In her experience, some students that she mentors would feel like they're a fraud, or they won't measure up to the expectation to successfully complete the class or program.

The researchers then switched the direction of questioning to focus on the barriers identified by the participant's organization. Also, if the barriers have been identified, if there are any limitations. Dr. Jackson responded with information about a recent webinar she attended. The webinar was hosted by the National Institute for Trade Technology and Science and it addressed key initiatives to exposing and attracting young students to the field of Computer Science and Computer Engineering. Dr. Jackson eagerly provided insight to some of the information she received that talked about recruitment and early exposure to the fields in K-12. According to the webinar's host, focusing on elementary-aged students is way too early, and it is way too soon to go after those students. It's great to present computer science and CIT and computer education to the students, but not in the sense of recruitment. She clarified that it should be considered more of career-awareness and not recruitment.

Dr. Jackson mentioned that she shared this information with some key stakeholders at her institution, so they could adjust their recruitment strategies and determine ways to be more efficient in their recruitment and, ultimately, retention strategies. In recruitment efforts, it's all about timing, not only for the students, but also the parents or others who are invested in that student's academic career. For example, for a high school junior or senior, it would be important to have someone from college admissions to be present during a school fair. Because once you get them interested, you can get them enrolled. Once you get them enrolled, putting them in the right classes is critical if they previously haven't been exposed to computer science. Dr. Jackson certainly agreed that exposure to the field for children as young as kindergarten was important, but there should definitely be a larger focus on recruiting at the high school level. In her experience, there is a drop off of URM students starting in the ninth grade, when more students are simply not interested. Dr. Jackson gave the analogy of "boots on the ground." Although it shouldn't be considered a war zone, there is a negative perception of not feeling safe in certain areas or schools. She recalled that her hometown in Mississippi did not move the needle of URM students in advanced placement courses or in exposing children to the possibilities available within STEM areas.

Dr. Jackson expressed her feelings of having a strong responsibility to actively recruit and be an example of success with the field of Computer Science and Engineering. She made it clear that she can't do it alone. She said,

> I'm only one person. So, I can't say that I'm going to go to every rural school…. I wish I could. Every rural school that's in the State of Tennessee or even in Middle Tennessee. And so, as I said before, with a Ph.D. or a Master's or anyone that's in this, and if you are a minority, it is your responsibility and duty to try to pull as many underrepresented kids to the field. The return on investment is there, but society would be better to have the diversity, and research shows that having a diverse workforce makes for better morale and better product.

She expressed a strong conviction to being available and present as a woman of color in the field of Computer Science and feels that it's her duty and responsibility to expose as many URM students to the field as possible. Although the data don't always reflect the number of URM students that an institution would like to recruit, Dr. Jackson remained positive saying even when there is only one student, that one student is making a difference.

Dr. Jackson then focused on specific recruitment initiatives and the role she plays in the recruitment process. Dr. Jackson referred to herself as an advocate and proponent to show children in local school districts what the institution has to offer. If her institution is hosting an event, she is often willing to do a tour of the facility where there are drone demonstrations or 3D modeling. She also gave examples of showing children various uses and possibilities of toys or gadgets they may have or know about, such as the Connect device. She strives to get them to see that they can create their own virtual world with some of these tech toys or even their mobile devices.

To conclude the interview, Dr. Jackson emphasized not only her goals as an educator but also her hopes for future generations of URM students with STEM. She says,

> You climb that ladder based off of the initiatives that are put in place. Those initiatives are put in place for a vital reason. And get on that opportunity. […] I know students: they feel that there's a lack of confidence. But as I said before, you're going to be seen anyway. You look at every challenge as an opportunity. And that's even what I say to my students when they are learning difficult subject matter. It may be a challenge now, but you're here to expand your knowledge, expand how you approach studying.

Drawing from her own experiences, she stressed the importance of how to approach the situation of being a minority in the field and how to overcome the lack of confidence. Dr. Jackson stated, "Expand on how you approach… and how you're going to approach your career. Because you're going to face challenges. It's going to be up to you to understand that this is still an opportunity." Dr. Jackson referred to a time when she was working on her dissertation, and she was employed by a research laboratory within the Department of Agriculture. She was inspired by the director of the research laboratory, who was a Hispanic male, who advised her to "take every challenge as an opportunity." At the end of the interview, Dr. Jackson provided a monologue of positivity and hope she has for making an impact within the URM STEM community. She shared these comments:

> The positive from this is, in these recent events with the Black Lives Matter movement really perpetuating around the world, just seeing more people… And it's a systematic thing, to see more people get involved and to understand that there are people who are our ally. And to see more people step up to say, "I stand with you. I understand it. I know that the journey has been long and hard, but we are here to make a difference, not just for my own community, for my own demographic community, but for everyone, to see that it has been refreshing." And it's one of those things that says, "Well, you keep going." Don't take offense about anything, …Drop it. Just because someone gives you an offense doesn't mean that you have to take it. So, it's kind of one of those things where you just lock on, and you keep going. You cannot fight alone. You have to have your allies. You have to have people who are willing to lock arms with you.

Interview 3: Dr. Davis

Dr. Earnest Davis, the executive director and president of the 501(c)3 nonprofit educational support center, North Alabama Center for Educational Excellence (NACEE), located in Huntsville, Alabama, opened the interview by describing his role and NACEE as a center that supports and serves minorities from many aspects, including preparing youth and adults for college and the workforce through several initiatives and federal and state funded programs. Additionally, Dr. Davis spoke about his role and how he later entered into the area of workforce development focusing on adult training and Emerging Scholars' Program. He specifically identified seven to eight federal TRIO programs that he manages and are funded by the U.S. Department of Education to support the center's mission. He described several programs focused on youth development, including ensuring high school and college completion, such as the Ronald E. McNair Post-Baccalaureate Achievement program, Talent Search, Upward Bound, and the Upward Bound Math/Science programs. He also mentioned a program focused on adult training and job preparation skills, the Veterans Upward Bound and the Educational Opportunity Center.

Dr. Davis explained that the Federal TRIO program policy legislation mandates that 67% of the program participants must be low-income and/or first-generation students residing in the 13 counties that the center serves in north Alabama. He then defined low-income/first-generation students as the federal agency labeled them, which was as "potential students." Based on Dr. Davis' explanation, potential students were recognized as students who had the potential to obtain the credentials to possibly go to college. Dr. Davis went on to explain in detail who the center considers minority groups and how the group constitutes a large part of the students they serve. He further explained that the minorities they serve consisted of African American, Hispanic, and Caucasian students or students meeting certain criteria for income level or overall socioeconomic status.

Through these programs and his 16+ years of experience in serving minority populations, Dr. Davis identified several barriers to academic success among the population but claimed that students' lack of exposure to STEM, the low-educational attainment of parents/guardians, and students' lack of motivation appeared to be key barriers to their success. He asserted that the first barrier was lack of exposure to STEM because, in Alabama, much focus has been placed on their basic educational foundations, which he identified as the fundamentals to get them through high school and into college. Also, in addressing students' educational experiences in STEM areas, he stressed that financial barriers did not exist only for students and parents (including barriers to paying for college), but that financial barriers also hinder the students' exposure to STEM in secondary schools. Dr. Davis noted that monetary issues are always of concern in some high schools because it can be costly to operate or develop STEM programs. The lack of high school programming thus leads to the lack of STEM-based common learning in elementary school and middle school classes. These external factors, he noted, result in minorities' lack of preparation for STEM programs, including deficiencies in math skills, and can occlude students' interest and performance in STEM throughout their education.

Dr. Davis returned to the original points he made earlier in the interview about the lack of motivation in minorities, and their interest to pursue science, math, and engineering courses. He attributed these obstacles to the lack of role models in the STEM field and little exposure in the community or school environment. Along with environments, Dr. Davis mentioned that without actually "having the know-how" or the academic background to express interest in STEM also plays a role in minorities not entering STEM fields. In order to solve the motivation barrier, Dr.

Davis proposed mentorship initiatives, which can involve people from the school system or family members. Dr. Davis noted, however, that some minorities may not have families that know how to support or motivate their children because of their own lack of awareness and lack of education beyond high school, thus limiting any conversations around STEM careers in the home.

Later in the interview, Davis also explained that minority students with limited options or career paths in STEM, mainly low-income and/or first-generation students from small towns throughout the country including small towns in Alabama, will less likely branch off to explore STEM in other areas. Dr. Davis added that this behavior was because of a fear of going beyond what they understood and knew, or because parents encouraged their children to stay at home to imitate community culture. Another “fear barrier” that Dr. Davis observed was the fear of math and science among both groups served by NACEE, adults aged 19- to 70-years old and school-aged students aged 12- to 18-years old. For adults, Davis often detected that fear during the individual’s preparations for entry or re-entry into the workforce, such as on-the-job training in the fields of nursing and cyber-security.

Regarding science and math courses as fields of study, Dr. Davis also commented that some minority students had low-confidence and did not pursue STEM because they believe STEM fields are for “geeks” and felt it is not “cool” to be a viewed as a “geek” or an academic scholar. He added that this perception of STEM as being for academic “geeks” is mostly perceived within the Black and Hispanic communities.

Dr. Davis affirmed that other factors, such as transportation and health issues, also interfere with minorities persisting in STEM because they both prevent regular school attendance, and in turn, also impact performance. He also argued that the COVID-19 pandemic unveiled additional disparities among minorities in service jobs, including lack of access to good health care, leading them to place more focus on family matters, such as maintaining a job, than school. Dr. Davis made it clear that these factors are common for the adults served by NACEE.

Another disparity he identified among the students was limited access to technology / internet. He said that, even though students were provided laptops by their school districts through a grant from Facebook, and even though more students were participating in NACEE activities virtually during the pandemic than in face-to-face activities before the pandemic, a large number of the NACEE participants and families in rural communities still did not have access to the internet.

Dr. Davis, however, also expressed some positive outcomes that were a result of COVID-19. He elaborated saying the pandemic forced schools and communities to think “outside the box” by, for example, equipping a bus with WIFI and placing it in the community so students could have internet access to continue their schoolwork online/virtually. He noted that another positive was that the pandemic forced students who are not usually exposed to STEM to be exposed to the concepts of STEM, such as learning and communicating using online classroom platforms. Dr. Davis related that he believed the students enjoy learning and interacting on virtual platforms, such as Zoom and Google Classroom, that NACEE started as a part of their support service. Supporting his assessment, he specified that the reaction of the students could have resulted from them being in their own homes and learning on their own time. He contended that moving their learning to their homes translates to the students that they have to make a commitment to their learning.

Even with these limited positive outcomes of the pandemic, Dr. Davis addressed the limitations of serving URMs in STEM. The barriers of money were again stressed, this time with respect to his organization. He shared that he and his staff are always searching for additional resources to effectively expose and prepare NACEE students for STEM education, whether they are grant-based, state-based, outside foundations, or other equipment sources, including individuals who are advocates for STEM. In regard to mitigating barriers as a result of limited resources, Dr. Davis also identified NACEE's (a) collaborations with the National Aeronautics and Space Administration (NASA) to obtain resources, such as equipment; (b) developing STEM-related programs, including summer programs with local Historically Black Colleges and Universities, J.F. Drake State Community and Technical College and Alabama A&M University; and (c) partnerships with the research institution at the University of Alabama, Huntsville. He expressed his appreciation for being in Huntsville, Alabama, a city that has a number of Fortune 500 companies and STEM-related businesses to assist in serving NACEE's students by providing local and non-local internships, including internships at Hudson Alpha Institute for Biotechnology in Huntsville, Alabama, and Google in Atlanta, Georgia. He shared that NACEE's students are also introduced to minority STEM organizations, such as the National Society of Black Engineers (NSBE) Jr. Chapter with NASA and the National Organization for the Professional Advancement of Black Chemists and Chemist Engineers at the University of Alabama, Huntsville.

As far as a specific strategy that NACEE used to mitigate barriers and is the foundation of the center's programs, Dr. Davis discussed NACEE's practice of implementing growth-mindset strategies to address minorities' interest and perceptions of STEM by helping them see their potential and the possibilities in STEM, including in math and science fields. He also suggested integrating "growth-mindset strategies" in a tutorial setting or support settings, such as after school programs, summer programs, and mentoring program. Earlier in the interview, he outlined these initiatives throughout the federal and state programs that he directs at NACEE. Through these programs, Dr. Davis shared that the students are also afforded the opportunity to prepare for the American College Testing (ACT) exam.

For specific outcomes and impacts of the programs, Dr. Davis directed the researchers to the NACEE's 2020 performance report called "Overview of Ten-Year Study of NACEE Outcomes." The report was prepared and written by Dr. John Reutter III, the CEO of the Reutter Group and external program evaluator, in April 2020. Dr. Davis granted the researchers permission to report the study results.

The 2020 report showed a significant impact on the high school and college completion rate of NACEE's participants compared to the national average completion rate. According to the report, as a result of NACEE integrating supplemental instruction in English, math, biology, chemistry, physics and pre-engineering, including tutoring services into the programs, 74% of NACEE-supported students enrolled in college after completing their NACEE-sponsored, college preparation activities (Reutter, 2020). The data revealed the NACEE college completion rate was 68%, which was 10% more that the national average at 58%. Reutter's 2020 report also demonstrated NACEE students outperforming the national average in job placement success. It revealed NACEE graduates achieved 95% placement in careers related to their academic majors, as compared to the national average of 89% (Reutter, 2020). The report did not specify whether or not the majors were STEM or non-STEM. Reutter reported these proven outcomes, regardless of the major, demonstrate that NACEE develops success as a way of life through their initiatives that provide learning support and expose underserved students to quality educational experiences.

Reflecting on minorities' limited exposure to STEM, Davis observed that White males have dominated STEM fields over the last 15 years, perpetuating the gap between minorities and Whites in STEM. He emphasized that when society started accepting minorities into STEM fields or "started breaking the glass," as he expressed, we learned that minorities can actually do well when they are afforded the opportunity and exposed to STEM. Dr. Davis quoted, "all students can learn through growth-mindset strategies, opportunities, and resource."

Interview 4: Dr. Hicks

Dr. A. James Hicks, a senior program director in the National Science Foundation federally funded program, Louis Stokes Alliance for Minority Participation (LSAMP), provided an extensive interview about his tenure in serving underrepresented populations in STEM education and workforce. Dr. Hicks clarified that the LSAMP program was originally known as the Alliance for Minority Participation (AMP) at its creation in 1991, and he often interchanged the names throughout the interview. In 1999, the name of the AMP program changed to LS-AMP after the retirement of its founder, Louis Stokes, the first Black congressman of Ohio, a civil rights pioneer, and as Dr. Hicks stated, a champion of education for all people.

Starting with a budget of about $15-$16 million dollars, Dr. Hicks explicated the budget grew to $46 million dollars with the increased need for the program. He explained that the mission of LSAMP is to increase the number of underrepresented minorities attaining advanced degrees in STEM fields. Dr. Hicks identified underrepresented minorities as African Americans, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, and Native Pacific Islanders.

Before Dr. Hicks began his role in the program in 1997, the program started with six alliances that were known as the "Grand AMPs": Alabama, Arkansas, California, Mississippi, Puerto Rico, and Texas A&M University-College Station. Since then, the program has grown to 55 alliances across the U.S, including the base group, Hawaii, and what he introduced as the "Islands of Opportunity." The base group contains Marshall Islands, the Marianas, Guam, and American Samoa. Dr. Hicks also highlighted another large alliance in the program called the All Nations Alliances, which includes 33 Tribal Colleges extending across 12 states. He explained the Tribal Colleges were grouped together for historical reasons and because they have an annual time when all tribes come together to take advantage of the opportunity to discuss how to get more of their students involved and how to retain them in STEM fields. Other Alliances, such as the Texas Alliances, Pacific Northwest Alliance, Midwest LSAMP Alliance Partners, California System Alliance, and the New York Alliance were also mentioned during the interview. A complete list of the LSAMP Alliances and locations can be found in the LSAMP 2018 publication, *A Program Modeling Group Impact*, that Dr. Hicks referenced.

According to Dr. Hicks' testimony and his reference to the program's 25th Anniversary presentation that included the MATHEMATICA Policy Research 2011 data, preliminary statistics for 2012 and 2013, and projections for 2014, the LSAMP program serves over 250,000 URM students in STEM per year. Dr. Hicks also shared more recent data that was reported in NSF's 2019 factsheet, *NSF By the Numbers*. The 2019 factsheet reported that LSAMP has helped produce more than 650,000 students of color to STEM. Considering the projections, Dr. Hicks believes this number has now increased to about 700,000 students. Although he credits the program's success to the 1975 Tinto Model that focuses on student development and retention, he noted the program realized "professionalization" was missing from the model. Therefore, LSAMP championed "professionalization" and added it to the model early on in the program.

Dr. Hicks emphasized that Tinto's model, along with the Professionalization component, has proven to be the best strategy used to address URMs' barriers to STEM. He directed the researchers to the 2000 Westat report to review the key elements in the strategy that aided in addressing multiple barriers, such as attitudes toward STEM, an individual's grit, family ties and structure (parental influence), geographic location, and financial barriers (Westat, 2000).

Dr. Hicks agreed that all groups in underrepresented populations have similar barriers. Regarding attitudes, Dr. Hicks claimed that URMs' interest in STEM is based on their educational experiences and environments. For example, he discovered that Pacific Islanders and Americans Indians were more likely to be interested in undergraduate research in the areas of Ecology and Environmental Science due to familiarity and their geographic location(s) and would less likely express a desire to participate in research in a larger city. As for educational experiences, Dr. Hicks recommended the YouTube video on NAPIRE that was published by the Organization for Tropical Studies. In the video, the research advisors explained how limited educational experiences prevent URM students from experiencing and understanding research, which also defers their interest in STEM. Family and financial factors were discussed briefly in the interview. One example that was shared about family was keeping the tribal colleges together in an alliance because of their family ties and the culture of their tribal community. Dr. Hicks also discovered that economic barriers and families that encourage underrepresented minority students to look for work after obtaining their first degree sometimes prevented URM students from pursuing an advanced degree in STEM.

While Dr. Hicks recognized that the groups had similar barriers, he stated that each single institution within an alliance have flexibility and is responsible for developing best practices that aligned with the Tinto model, including professionalization. He stressed that institutions should focus on key elements that worked best for the students they serve because not all student bodies have the same need. For example, the 2000 NSF Westat report specified that while sharing the same goals as four-year institutions, two-year community colleges have a more specific intermediate objective which is the requirement to retain students and prepare them to transfer successfully to four-year universities in a STEM field.

Dr. Hicks also referred to a 2006 Urban Institute report (Clewell et al.) to identify the several initiatives that were implemented under LSAMP's Tinto Model that is inclusive of professionalization. These initiatives were found to have the same impact on community college and four-year college students:

> Although there are some demographic differences between LSAMP participants who began their studies at a community college and those who did not, no differences between these two groups are found in the program outcome. (p. 18)

The evaluators of the 2006 report recommended strengthening the focus on community college students and also described the key strategies and initiatives employed by the LSAMP program, which were categorized into three categories: social integration, academic integration, and professionalization. These categories were also emphasized by Dr. Hicks in the interview. According to the report, social integration, which is part of the 1975 Tinto model, included activities and initiatives that provided spaces and opportunities for URMs to establish a sense of belonging and to grow socially within the STEM field. The academic integration component of the Tinto model focused on activities and initiatives that develop positive interactions between URM students and the institution. Professionalization, as Dr. Hicks described it, focused on creating and developing career identities and enhancing the grit in minority students in STEM through undergraduate research, internships and team led research projects with four-year university faculty and research institutes. Dr. Hicks suggested the 2019 book that was published by the National Academies of Sciences, Engineering, and Medicine, *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce.* The 2019 book described the academic, personal, and professional development strategies of LSAMP as means to building a sense of community among URM students in STEM. Dr. Hicks indicated that one of the most significant strategies of the LSAMP model is professionalization because it includes exposure to undergraduate STEM research. He shared several undergraduate research opportunities that were featured in the LSAMP 2018 publication that exposed URM students to national and international research.

- NAPIRE: NSF LSAMP REU (Research Experience for Undergraduates) for U.S. Underrepresented Minority Students Summer Program in Costa Rica *(Targets American Indians and Pacific Islanders because of their interest in Ecology and Environments)*
- NSF-LSAMP Internship at the U.S. Department of Energy's Brookhaven National Institute Laboratory
- NSF-LSAMP /Chemistry International REU in France

The reports and publications that were recommended by Dr. Hicks during the interview, exemplified a significant impact on URMs completing and transferring to STEM programs as a result of the LSAMP Alliances implementing activities and initiatives that were centered on social and academic integration and professionalization efforts below.

Table 2. LSAMP Initiatives

	Social Integration	Academic Integration	Profession-alization
STUDENT			
Summer Bridge	x	x	
Scholarship/Stipend	x		
Peer Study Group	x	x	
Tutoring	x		
Skills-Building Seminar	x	x	
Learning Centers	x	x	
Academic Advising	x		

	SOCIAL INTEGRATION	ACADEMIC INTEGRATION	PROFESSION-ALIZATION
Summer Academic Enrichment	x		
Research Experience	x		x
Mentorships	x	x	x
Conferences	x	x	x
Internships	x	x	x
Career Awareness			x
GRE Test Preparation	x		x
Graduate School Admissions Support			x
Graduate Summer Bridge	x	x	x
FACULTY			
Workshop on Teaching	x		
Diversity Sensitivity Training	x	x	
Faculty Research Program	x		
INSTITUTIONAL/DEPARTMENTAL			
New Course Development Curriculum	x		
Material Sharing	x		
Distance Learning Courses	x		
Changes in Institutional/Departmental Policies and Practices	x	x	x

Adapted from: Clewell et al., 2006, p. 25.

Later in the interview, Dr. Hicks returned to the 2006 Urban Institute (Clewell et al.) report and presented evidence that LSAMP participants were more likely to complete a graduate degree in STEM than non-LSAMP participants, including whites and Asians. Earlier in the interview, Dr. Hicks discussed that URMs were less likely to attend graduate schools because of limited finances. To help tackle this obstacle, Dr. Hicks acknowledged LSAMP's partnership with Educational Testing Service. The service provides all former LSAMP participants 50% off the cost of Graduate Record Examination (GRE), which is required by some graduate schools before entry. Dr. Hicks commented that this initiative aims to increase the number of URMs pursing graduate degrees in STEM. According to Dr. Hicks and the reports referenced, there are about 20,000 to 25,000 graduates coming from the LSAMP program per year and make up an increasing percentage of URM students who obtain baccalaureate degrees in STEM fields and beyond. The UI LSAMP Graduate Survey and NSF NSRCG Longitudinal File (Clewell, 2006) also revealed that the national comparison group statistic was not much different from LSAMP data (pg. 17):

- LSAMP Participants: 45% completed grad degrees in STEM
- National Underrepresented Minority: 19% completed grad degrees in STEM
- National Whites and Asians: 18% completed grad degrees in STEM

During the interview, Dr. Hicks also pointed out the significance of using data to identify the needs of serving specific minority groups, such as American Indians and Pacific Islanders. Not only did he reflect on the importance of using data, he also emphasized the significance of sharing data, especially when seeking national support for underrepresented populations in STEM. He stated,

> I would make that appeal at national meetings early on to graduate deans and they would tell me invariably that, "Oh, we can't find them. We can't find students of color who are interested in doing STEM work." And I said, "You are not looking in the right places." I said, "Now what you need to do is to partner with the LSAMP program." But they said to me, "Dr. Hicks, we don't find the kind of students that you're talking about." Because I was giving them large numbers, 20,000-25,000 graduates coming from the LSAMP program per year. And they said, "Sure, we don't see those kinds of numbers, WHERE ARE THEY?

Dr. Hicks concluded the interview by sharing his publications that reflected years of LSAMP work and URM scholars in STEM. He accentuated the importance of proving naysayers wrong by providing potent data and success stories of URMs in STEM, especially when recruiters imply "there are no students of color in STEM." As Dr. Hicks reiterated, the proof is in the numbers, and the LSAMP reports and publications proved there are over 650,000 students of color in STEM, and STEM recruiters from institutions must be intentional about where they are looking for URMs in STEM.

Interview 5: Chief Diversity Officer

The participant for the final interview brought the perspective as the Chief Diversity Officer from a four-year PWI research-intensive university located in the southern United States. This participant introduced experiences of URM student populations in a STEM area from a four-year perspective. After the introductions between the researchers and the participant, there was a discussion of common experiences with URM student populations in STEM. Both the researchers and the participant worked directly with URM student populations in STEM higher education, and the conversation began from scope differences of URM student populations at a four-year university.

The participant holds a doctorate in a STEM area of study. Aside from their current position, the participant brings over 15 years of experience working in the STEM area of study, in programming and efforts to support the retention, recruitment, and success of minority populations. It was explained that some of the work has been supported by federal agencies and local agencies. However, some have been university-wide or within a single academic unit. The interviewer led with a question pertaining to employment after graduation for URM students. While the participant did not have a direct answer for that question, the question about past and current work in efforts to assist students with professional development within a degree program was answered. The participant raised another important aspect related to the preparedness of students entering college. The participant stated:

> There are some students who are very well prepared and who enter into the ecosystems of higher ed which are not supportive of their presence and success. Students may experience chilly climates and under-recognition of their potential to STEM scholars and researchers, they may not have access to the knowledge currency which gives them access to things like internships and other opportunities, which then build their credentials for success at the next level. And there are some other exclusionary factors which may play a role in how they navigate their units, their departments in those

> institutions. And so, when we think about those barriers, sometimes they're individual barriers, and I think they're sometimes institutional barriers.

The researchers then followed up with questions about the benefits of exposure to STEM activities in elementary school and K-8 STEM programming. The participant considered the question interesting because according to familiar data from the Higher Education Research Institute, which was shared by the participant, there is research that suggests that there is a freshmen interest in STEM. From the data, they highlighted that regardless of minority vs. non-minority status and aside from those students who enter into the universities as freshmen had high interest in STEM and coalesced among different subgroups. After providing the data from the research, the participant raised another question, "What happens when they show up?" The participant further avowed that the need for pre-college experiences is important, but also described other challenges. The participant followed with:

> One challenge is, is you can have really strong outreach and STEM experiences at the elementary level. But then if you have students who are not advised properly or who don't have access at the middle school or high school level, they may have interests, but they still haven't been cultivated to be successful in their first year or first few years…. And so, I think that we, in terms of the community, need to build in ways that we are reaching out to stroke those interests very, very early on. But we also need to think about what we're doing in our colleges, and our universities to support the students. And that's by no means disconnected from the pre-college experiences at the middle school and high school levels.

From their perspective as a four-year administrator, the participant continued with sharing a challenge that was unique as it relates to academia. They described that one of the major challenges of research universities is that, oftentimes, faculty in research universities are focused on research and not undergraduate education. As explained by the participants, these behaviors cause URM students to no longer be the focus, and they need support in a predominantly White academic environment to excel. The participant further explained how this lack of focus leads to "their differential experiences in terms of what that culture looks like when you compare it to other university types: Community colleges, liberal arts colleges, primarily undergraduate institutions, minority-serving institutions such as HBCUs or HSIs, or tribal colleges and universities….” Working or attending a research-intensive university tends to lead to opportunities and exposure but are these types of institutions providing a nurturing environment? Do these institutions cultivate a sense of belonging?

Relating to the best practices and activities that assist in mitigating barriers, the participant offered an explanation about first-year interventions for students. As explained by the participant, the responsibility for the participant’s unit is to assist other units across the campus community to support early success of students. The participant described these first-year intervention initiatives as growth opportunities. According to the participant, several efforts have been initiated within student support services. The participant added, “there are several groups at the university level and a strong office of diversity that seeks to provide homes, connections, connectivity, academic support, social support.” One area of contingency lies among the faculty and how faculty can be truly engaged in the process of learning about barriers among URM student populations and how to implement best practices to mitigate those barriers when interacting with URM student populations. Though not in the sense of a final achievement, the participant did acknowledge growth in retention of the URM population and admits the discussion continues ways the institution can best support its students. The first-year interventions are a collaboration with academic affairs and student affairs. The participant’s office also works with advising units around the campus. It was further explained by the participant that most of the collaborations are internally with the college and not with outside agencies or organizations.

In identifying persistent issues with students who are hesitant to go into an area of a STEM discipline, and common barriers, the participant pointed out that "their [URM students] success in those, that academic success in those programs, and whether or not they learn to navigate challenges is one thing… A sense of belonging is another thing." The participant expressively shared the theory that students, no matter what their background, are going to face challenges. Posing a question, the participant asked, "how do student learn to navigate those challenges effectively to resolve the problem or issue that is presented?"

The participant rhetorically asked: "What does that mean? How do you navigate that?" Also, in reference to other student challenges, the participant asked, "Do you internalize that challenge and speak to yourself as though you are not able to do it?" The participant continued the conversation by discussing the nuances of perceptions — external perception and self-perception. The conversation continued with descriptions of science identity and imposter syndrome and how these two personality internalizations may cause URM students with high confidence feel as though they do not belong in the field and cause them to give up. The participant followed with an example of a student who is not being engaged in the classroom experiencing feelings of isolation. This student will most likely not feel empowered to seek out the instructor and attend office hours. The participant added that additional behaviors from both the instructor and other students can lead URM students to experience the imposter syndrome, ultimately affecting the student's confidence and ability to adapt, and inflict environmental, personal, and institutional barriers. The participant concluded with this statement, a personal account, in reference to their work in serving URM populations, "I'm a firm believer in personal responsibility, but I'm also a firm believer in supporting our students. I can't do the work for you, but I can certainly help to build a system that supports your success."

Analysis of Interviews

The interview participants each provided valuable insights, as well as descriptions of significant successes from their work. In analyzing these interviews as a group, several themes emerged. Table 3 summarizes these themes and barriers.

- Theme 1: Barriers at the individual level, such as attitudes, belief systems, family structures/backgrounds, and an individual psychological position, where reported as influences on URMs decisions to pursue or remain in STEM along with individual support and growth strategies to best navigate them.
- Theme 2: External barriers related to educational access, implicit biases, STEM climates, and the collaborative efforts to alleviate them also emerged from the participants in the study.
- Theme 3: Strategies to diminish institutional barriers linked to campus culture, limited funding, faculty and student engagement, delivery of STEM instruction, and curriculum design were identified during the analysis.

Table 3. Themes: Barriers and Mitigating Strategies

BARRIERS	DESCRIPTION	STRATEGIES
Individual Barriers	• Lack of belief in self-ability • Perception of level of difficulty of content • Feelings of isolation • Lack of family support • Low-education attainment of parents • Low socioeconomic status • Racial stereotyping towards women and URMs • Social psychological barriers • Stress and poor coping skills	• Early Engagement in STEM • Family engagement initiatives • Growth Mindset strategies • Mentorship initiatives • Develop career awareness and identity

BARRIERS	DESCRIPTION	STRATEGIES
External / Environmental Barriers	• Lack of exposure in home and schools in impoverished locations • Experiences of microaggressions and macroaggressions regarding ability to succeed in STEM • Negative peer influence • Childcare and transportation issues • Cultural disconnects that impact school and work-life balance • Limited STEM jobs in geographic area • Limited access to quality healthcare • Limited access to quality education experiences • Experiences with racial/gender biases and discrimination	• Early engagement in STEM • Collaborations and partnerships with workforce organizations • Involvement of community leaders • Partnerships with secondary and post-secondary schools • Federal and state funding to unlock resources and promote STEM engagement and workforce programs
Institutional Barriers	• Lack of exposure in K-12 • Lack of support for STEM activities • Financial barriers to pay for post-secondary education and/or training • Lack of minority faculty/staff representation • Lack of faculty/staff support and mentorship • Academic under preparedness in collegiate STEM coursework • Structural barriers	• Develop retention and intervention strategies that help meet the basic needs of students • Intentional Outreach • Intentional support an engagement from high school and college faculty and staff • Policy changes in advising and pathways; Curriculum design • Align campus/institutional culture and climate • Increase faculty involvement • Funding to support STEM initiatives, programs and ongoing faculty STEM training • Financial and student support

Theme 1: Individual Barriers and Strategies

With minimal prompting by the researchers, each participant identified several individual factors as barriers to STEM. Given the variations of each participant's respective roles in serving URMs, some individual-based barriers were emphasized or acknowledged more than others by participants. For example, all participants identified the limited educational experience of parents and its impact on URMs' interest and awareness about STEM careers. Both participants 1 and 3 contributed the lack of awareness and exposure to STEM to the low-educational attainment of parents. Participant 3 claimed that conversations about STEM careers were more than likely omitted from homes due to the education level of parents and low expectations from parents. P3 also described how the culture of the Black and Hispanic population and their family obligations affect URMs' interest in STEM, especially in small towns. Concurring with this perception, participant 4 discussed the culture and family ties of Pacific Islanders and American Indians and the impact they have on their decisions to pursue STEM and remain in STEM. The low expectations of parents and families were discussed by participants 1 and 3. Participant 1 tied this factor back to the lack of awareness and simply "not knowing." Connecting to this issue, P3 expressed his views on minority youths not having families that know how to support or motivate them. P3 also supported P1's sentiments by introducing the fact that without role models and families without the academic background can result in minorities not knowing or "having the know-how" to enter STEM.

P3 singled out the cultural behavior of URM families, and some encouraging their children to stay in their hometowns to imitate the community culture or not to deviate from family norms. In the same content, P3 also acknowledged that this factor has affected the hesitation of minorities and affected their resistance to exploring STEM careers and schools in other areas outside their hometown. Recognized by participant 1, the behavior to this type of fear is associated with not knowing. Participants 1, 2, 3, and 4 highlighted minorities' fears of math and science and their perception that these areas are difficult to pursue. This perception circled back to the lack of knowledge and awareness and, as participant 1 noted, and the influence it has on minorities' perceptions of STEM. The belief that STEM is difficult and a harder path to success was noted by P1. Participant 2 linked this factor with URMs' negative perceptions about STEM resulted in selecting non-STEM areas or schools because they were perceived as safe.

Some of the participants also talked about minorities' attitudes and feelings once they make the decisions to pursue STEM. Participants 2 and 5 mentioned minorities sometimes feel inadequate or don't believe that they could pursue or excel in STEM and often have imposter syndrome. With these challenges, P5 questioned URM populations capacity to navigate them. They asked, "What does that mean? How do you navigate that? And that's a simple question, but you can imagine any number of challenges the students may face. And do you internalize that challenge and speak to yourself as though you are not able to do it?" As for self-efficacy, P3 talked about the lack of motivation in minorities, and their interests to pursue science math and engineering courses.

Participants 1, 2, and 3 also connected the lack of motivation to the lack of role models in STEM. Finding the lack of role models to be a contributing factor to URMs' feelings of isolation, P2 mentioned how URM students, including women, are usually excluded from STEM conversations. Participant 5 agreed that the feeling of isolation also affected the retention rates of URM students. Also, as it relates to self-efficacy, P4 mentioned the need to enhance the grit of minorities and linked the attitudes towards STEM with obstacles related to educational experience and the environments.

The strategies presented by the participants were surprisingly similar. To address the influences of parental factors, including lack of awareness, participants 1 and 3 employed engagement strategies that included families. At the state level, P1 discussed and described several services and initiatives that included educating families, parents, and grandparents about financial literacy, STEM careers, and more. Participants 2, 3, and 4 discussed their engagement and implementation of mentorship initiatives and programs to address individual-based barriers. At the community college level, P2 found it effective to be intentional about mentoring students of color. As a community leader of an education center, P3 discusses the implementation of mentoring programs along with the integration of growth mindset strategies to address barriers that impact minorities' interest and perception of STEM, namely math and science fields. As a national effort, to spark the interest and retain minorities in STEM, P4's program LSAMP integrated a successful mentor model that includes a faculty research and peer mentor model. Also, among these strategies, P3 and P4 stressed the importance of developing career awareness and identity to retain minorities in STEM. Participant 5 also integrated professional development strategies for URM at a national level in the national program that supports HBCUs and HSI colleges and universities, including many community colleges.

Theme 2: External / Environmental Barriers and Strategies

In analyzing the data, all five participants realized that URM had poor pre-college preparations that impact their success in STEM. From his experience and the personal experience of his colleague, P1 linked individual factors, such as parental support and low socioeconomic status, to limited exposure to quality educational experiences. In the same sense, P2 argued that states, such as Mississippi, are not focused on STEM development in the K-12 school system. Participant 3 also declared the lack of exposure to STEM fundamentals as a barrier to STEM success. This assertion was echoed by P3, who linked the minorities under-preparedness of STEM course work to the massive disparities in education in secondary educational systems and access to quality to resources due to poor funding sources to produce or support STEM programs.

Among these disparities, P2 briefly acknowledged systemic racism as causing the disparities relating to the problem. More specifics were provided by participants 1, 4, and 5. These three participants directly and indirectly referenced implicit bias, stereotyping, and perceptions of URMs' abilities in STEM. While P5 directly mentioned the threats of stereotyping and its potential to intensify URMs' feelings of isolations, participant 1 indirectly implied that URMs, such as Latinos/Hispanics, are not being viewed as capable of performing well in STEM when he stated, "students [referencing the Latinos/Hispanic in a state project] regardless of their background could be taught STEM when given the opportunity and without the perception that they can't." The argument of P1 was supported by P4's direct experiences with what he called "Naysayers." As a national effort to increase minorities in STEM, the naysayers from different organizations, including graduate schools, argued that there weren't any qualified students of color in STEM to recruit. These organizations simply did not believe such students existed. Participant 5 also identified a widely held belief that URM students were "not interested" in STEM, particularly Pacific Islanders and American Indians, because of their geographic location. Participants 3 and 4 supported this point, noting that these students had limited access to career paths in STEM.

When mitigating barriers related to limited exposure weak pre-college experiences, each of the five participants were clear on the necessity for early engagement in STEM, starting in the K-12 system. Collaborations and partnerships were also identified as ways to lessen barriers. Participant 1 emphasized the necessity to combine workforce development, economic development, and education efforts when addressing complex matters such as the STEM workforce gap. He and P3 maintain partnerships with both secondary and post-secondary educational systems in their efforts to holistically serve URM populations from pre-college to the workforce. Both participants acknowledged that they receive state support to include funding to promote STEM engagement and workforce programs. In addition to state funding, P3 seeks and secures funding from federal government agencies and other local resources, including in-kind services to help mitigate the barriers of URMs. According to P4, he has established a substantial number of alliances and partnerships across the U.S., including in Hawaii and Puerto, to address the issue on a larger scale. His alliances consist of partnerships at the national level with four-year universities, community colleges, and various organizations. With the exception of P5, the participants engaged in collaborations with industries to provide URM STEM-related internships, research opportunities, and workforce training. Participant 5, who is employed at a four-year, research-driven PWI, mentioned that the university utilizes more internal resources and does not have a lot of external collaborations because of an abundance of resources at the institution. When meeting the needs of URMs in STEM, P2 quoted the director of Code.org, "everybody got to be involved." In the interview, the participant clarified by adding, "I mean stakeholders, and the governor."

Theme 3: Institutional Barriers and Strategies

Because of their roles and/or collaborations, participants 2, 4, and 5 were the only participants in the study who were able to speak on institutional-based barriers to serving URMs in STEM and interventions and practices averting the risks. Barriers related to the lack of recruitment and retention efforts emerged from the interviews. Toward recruitment, P2 implied that when recruiting URM in STEM, especially in the field of computer science, institutional leaders must be deliberate. P2 also pointed out the low enrollment of women in STEM and contended that recruitment is all about timing, and that efforts must not only consider targeting students, but strategies must also focus on parents or any stakeholders who are invested in the student's academic career.

In referencing retention strategies, P2 stressed the criticality of placing students in the right introductory STEM courses once they are enrolled. She further clarified that placing URMs in the right beginner courses “keep students hooked if they were not exposed to computer science at all.” Consistent with P2’s expression about the necessity to enroll students in the right courses in attempts to retain them, P5 mentioned that their institution lacked focus on undergraduate course work because of their faculty’s focus on research. Moreover, participant 5 admitted that the institution needs to work more on retention efforts in URMs first-year experience.

While P5 drew attention to the need to have less focus on research and more attention on undergraduate coursework, P4 highlighted the need for minorities to participate in undergraduate research as a means to build career identity and professional development. It is important to clarify that P5 works in a PWI and P4 focuses on extending research opportunities to URMs at HBCUs, HSIs, Tribal Colleges, and other minority serving institutions. During the interview, P5 announced that their PWI does not exude a campus culture that nurtures minorities. Concerning minorities, the participant explained, “STEM climates are not welcoming and do not cultivate a sense of belonging.” As reported by P5, the college has many resources but lacks the nurturing culture that community colleges, HBCU, HSIs, Tribal Colleges, and other primarily undergraduates and minority-serving institutions offer. Participant 5 shared that heterosexuals or whites will more than likely have a sense of belonging at the institution; creating a welcoming place for students of color is a growth opportunity for the institution.

Responding to the needs of URMs at minority serving institutions, the federally funded national program LSAMP directed by P4 utilizes the Tinto Model to focus on student development and retention. The model includes integrating academic and social support in institutional strategies in efforts to provide spaces and opportunities for URMs to establish a sense of belongingness and social growth within STEM fields, including the development or promotion of on- and off-campus STEM organizations. Although P5 acknowledges the barriers of their institution, they accepted that although the institution's diversity area seeks to provide academic support and social support, engaging faculty is a struggling process. P5 noted, "As with many institutions, how we engage faculty in those processes is something that we are struggling within and know would provide even greater support in mitigating barriers."

Although P1 and P3 did not speak directly to institutional barriers and strategies, common themes of strategies were connected with best practices recommended and utilized by P2, P4, and P5. For example, making STEM relevant to URMs and establishing comprehensive STEM pathways were mentioned by P2, P3, and P4 in efforts to retain and ensure student completion. P4 and P5 also discussed the need for faculty engagement in institutional efforts to lessen URM barriers to STEM. P4 referenced the LSAMP model, which includes providing workshops on teaching STEM diversity sensitivity training, as a means for creating a campus culture that fosters a sense of belongingness. Other strategies included accessing resources, including state and local funding, to support the needs of URM students and STEM programs, such as intervention initiatives. These strategies were mentioned by P3 and P4. Just as P1, P2, P4, and P5, P3 also utilized and recommended active outreach and recruitment initiatives. In the same context, participants 1, 2, and 4 alluded to the notion that you have to meet URM students where they are and go where they exist to actively engage them in STEM. However, P4 affirmed that institutions need to develop best practices that they believe are best suited for the population and communities they serve. He reaffirmed with an observation by stating, "not all student bodies have the same needs." P2 summarized the collective strategies for institutions, as they concern students, by quoting her church pastor, "we have to Invest, Invite, and Include the people we serve."

Summary of Findings

The data described above defined the themes in this study, which emerged from the majority of the interview questions, and guided the best practices model and recommendations that follow in Chapter V. The responses showed that participants, regardless of their role in serving minorities, have observed similar barriers between URM groups that hindered their representation in STEM education and the workforce. For the most part, the findings were consistent with descriptions and specific quotes. Table 4 reflects the consistency of the themes in the narratives of the participants.

Table 4. Participant Quotations by Theme

	THEME 1: INDIVIDUAL BARRIERS	THEME 2: EXTERNAL BARRIERS	THEME 3: INSTITUTIONAL BARRIERS
Participant 1	Saying "I don't like Math, or I don't like golf," but they never played it. I don't like this.	Well, if the parents are not educated along those lines of technology, then it's not happening.	What can we do to keep up?
Participant 2	And many students that I have encountered that speak with me about it, they feel that way. It's kind of like eventually someone will find out that I am a fraud…	…they come from rural backgrounds, and they're not really introduced to Computer Science.	Boots on the ground
Participant 3	"…most students feel like it's not "cool to be a geek; it's not cool to be a scholar in that sense."	Started breaking the glass	Well, there is always the barrier of money.
Participant 4	Because I have no help from anybody and so how am I going to go to grad school? I can't ask my mom and dad for any additional money.	Naysayers	Relatively small campuses … where they did not have an opportunity do a piece of research on the individual campus.
Participant 5	And we can have great, brilliant students who are disadvantaged in terms of understanding.	Students may experience chilly climates and under-recognition of their potential to STEM scholars and researchers.	We are struggling within within and know would provide even greater support in mitigating barriers.

In analyzing the interview content, both researchers discovered that individual-based and external-based factors seem to be uncontrolled and perpetually inevitable. In completing the analysis, the researchers also realized that some individual-based factors could be mitigated through external and institutional strategies but will require key stakeholders to solve the problem. This theory is mainly due to the different complex layers of the underlying factors and the ripple effect of each factor. This theory is mainly due to the different complex layers of the underlying factors and the ripple effect of each factor. It is apparent that institutions of higher learning, particularly community colleges are the centralized links to connecting all key stakeholders. The data revealed that with the right stakeholders and equal distribution of quality educational experiences, regardless of socioeconomic class and racial ethnic background, integrated with multifaceted support systems and comprehensive pathways to STEM can significantly narrow the gap in STEM education and workforce. Contrary to findings, the researchers recognized limitations in the study, primarily concerning the number participants interviewed and their roles and URMs' perceived barriers and solutions.

Conclusion

Each participant shared key stakeholders who are needed to address the issue and implied that it is a task that cannot be done alone. In their efforts to resolve the issue, each participant communicated the importance of establishing a shared responsibility with stakeholders to create best practices that help eliminate or mitigate barriers that lead to the underrepresentation of minorities in STEM. Improving awareness and providing recommendations to address the barriers of URMs can potentially help shrink the racial gaps in the STEM workforce and promote innovation and increased production capacity and advance global competitiveness in STEM fields. Thus, lessening the skills gap and increasing diversity in the STEM workforce. There is no single solution to address barriers. A multi-pronged approach and collaborative efforts in increasing the awareness and exposure to STEM fields at earlier ages and across all school systems are urgently needed. Chapter V presents best practices to address the multipart layer of barriers to URMs' Success in STEM.

Chapter V: Best Practices Guide for Addressing Barriers to URMs' Success in STEM

Introduction

According to the literature review and participants in this study, success is rare for underrepresented populations in STEM because of barriers deriving from societal and cultural factors that affect individuals, environments, and educational experiences in STEM. Hence, much attention is needed on increasing the overall community educational attainment of some college, or an associate's degree in STEM areas. Although there is a higher educational attainment of high school graduates or higher, the community colleges must focus on strengthening K-12 partnerships and developing new practices that are aimed at improving the recruitment, retention, engagement initiatives, and the preparation of underrepresented populations in STEM fields. Many studies and key individuals in roles that serve URMs have proven that intentional strategies aimed at lessening the impact of barriers have the potential to increase the representation of URMs in STEM.

It is well known that community colleges play a pivotal role in bridging the gap between K-12 systems, four-year universities, community leaders, and industries. Community colleges have the ability to share the responsibility of addressing individual, external, and institutional factors that hinder the success of URMs in STEM. To address these barriers, community colleges can initiate best practices that focus on *Student-Centeredness Initiatives*; *Community-Wide STEM Engagement*; and *Institutional Changes* to recruit, retain, and graduate more URMs in STEM.

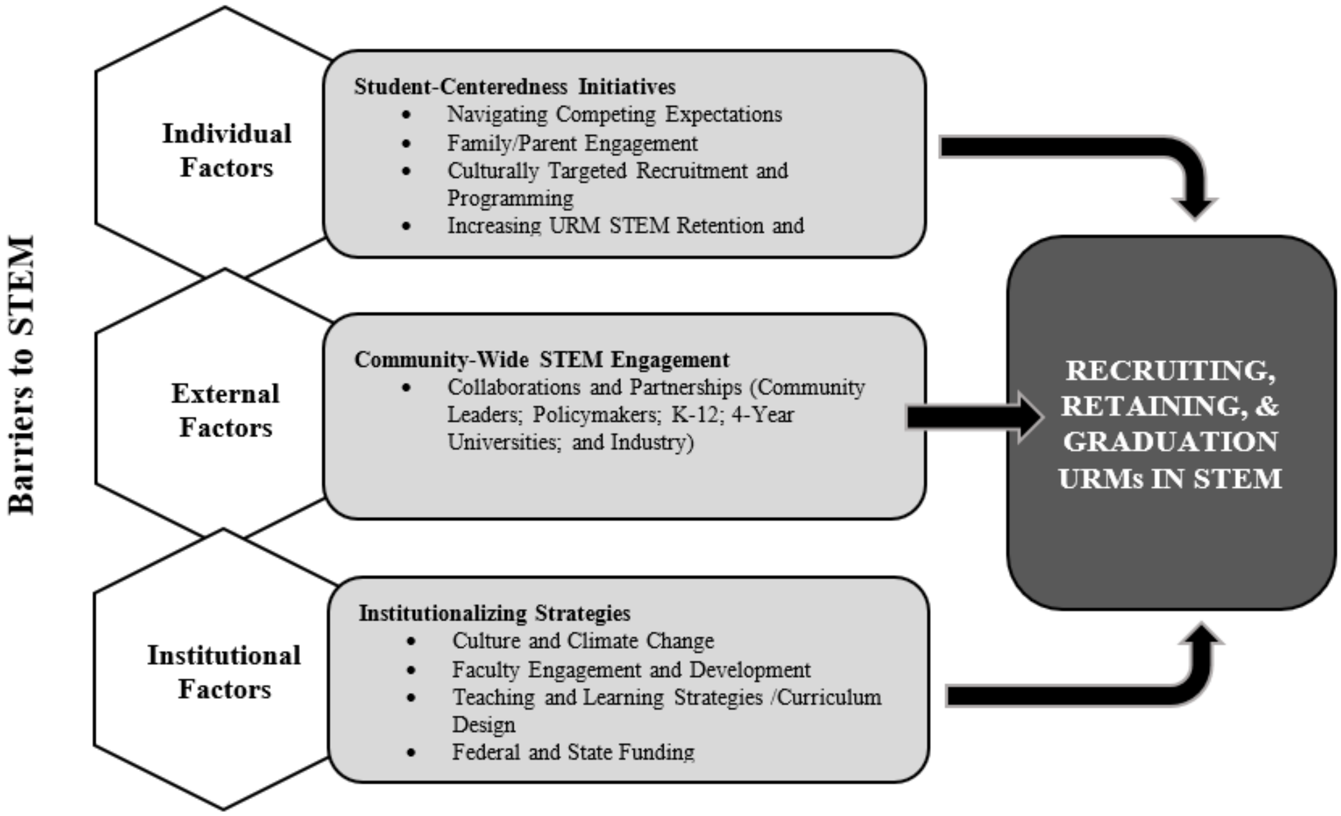


Figure 7: Proposed strategies to mitigate barriers (PS-MB) Model

Addressing Individual Factors

The following student-centeredness initiatives and strategies will address individual motivational beliefs, beliefs about their own intellectual ability, and expectations for success in STEM. Helping students navigate competing expectations, such as their families, community, and peers will be a salient factor for most URM students in STEM.

- **Navigating Competing Expectations**
    - Provide emotional support, such as reassurance and positive feedback on their abilities and providing them a designated safe environment to learn.
        - *Institutionalize Student Growth Mindset Strategies* to cultivate a healthy relationship with achievement in STEM. Implementing practices such as Carol Dweck's Growth Mindset will promote long-term learning and achievement among students. Students across the ethnic spectrum and among both low-income

and high-income students, beliefs about their academic ability influence their academic persistence (Dweck et al., 2014).

        - *Intrusive Advising*: Intrusive advising will provide clear directions and practical steps for students to reach their intended goals and help students develop a growth mindset. Intrusive advising is designed to foster personal connections with students (Center for Community College Student Engagement, 2013). This practice will improve intentional engagement, consistency, and help students become more connected to the college and their purpose.

        - *Diverse Peer and Faculty Mentorship:* Peer and faculty mentorship will provide students with psychosocial and academic support to generate a sense of belonging, which in turn increases engagement. Also, a Wall of Fame of alumni successful URM STEM students will help students envision themselves in the same position. Allowing students to see other minorities in their STEM fields will more than likely retain students in STEM education (Funk &Parker, 2018) and help shape their career identity.

- **Connecting Students to STEM Community**
    - Increase online/anytime, secure social networking sites, such as GroupMe and Facebook, to build a community of support with current and URM STEM students and alumni
    - Make STEM activities relevant to real-world issues
    - Invite Bilingual/Multilingual speakers and other underrepresented minorities regularly to participate in discussions
    - Establish or Increase STEM Organizations/Clubs
- **Improving Family/Parent Engagement**
    - Create a family environment and invite families to campus events and program related activities
- **Developing Culturally Targeted Recruitment and Programming**
    - **Implement a College Student-High School Mentor Model:** Establish community college minority student mentors for secondary school minority students to provide role models and streamlined pathways to higher education for K-12 minority students.
- **Increasing URM STEM Retention and Completion Strategies**
    - Provide a one-stop shop for resources that includes:
        - Designated STEM Center/Support Facility
        - Financial Support: Scholarships, paid internships and apprenticeships, childcare and transportation assistance
        - Counseling Services

        - Tutoring and Peer mentor program for URM students in STEM
        - Student Coaching initiatives for first-year student support in STEM
    - Establish a retention and intervention plan, including an early alert system for students at risk of failing a STEM course or program
    - Improve the intake process (add a STEM orientation that outlines pathways)
    - Provide professional development workshops for STEM students, internships and job opportunities
    - Assess and review student performance and progress

Student-serving institutions should be collaborative in developing and implementing a "student-centered mindset" that meets students where they are in Learning and Life. Providing consistent student-centered services will help guide students in reaching their highest potential and produce a skilled STEM workforce.

Addressing External Factors

Strategies to address external factors can be complex; therefore, strategies must focus on collaborations and establishing partnerships to create a shared responsibility among stakeholders that helps mitigate the impact of external factors, such as limited educational experiences, classroom/STEM climates, gendered and racial microaggressions, etc. Collaborations and establishing partnerships can help create a broader connection to the STEM fields.

- **Community-Wide STEM Engagement** (increase public awareness)
    - Establish partnerships with community leaders, policymakers, K-12, four-year universities, and STEM-related industries to increase awareness about the barriers to STEM and need for collaborations and diversity. A STEM consortium would be ideal for this initiative to gain diverse perspectives.

    - Community Leaders: Educate and Engage community leaders to help guide the community through the STEM awareness and community engagement initiatives and ensure a widespread of representation. Community leaders could include churches, non-profit organizations, local state representatives, etc.

- Policymakers: Advocate for national and state policy makers to make quality educational experiences in STEM accessible for all students across grade levels and invest in sustainable and comprehensible support for STEM education and teachers.

- **K-12 Systems**
  - K-12 Teacher STEM Training: Community College faculty can lead STEM training initiatives and support continue learning credits for K-12 teachers.
  - K-12 and Community College Consortium/Curriculum Collaborations: Coordinating STEM curricula, delivery methods and assessing the performance of students to ensure college readiness.
    - Dual Enrollment: Establish dual enrollment/early college agreements with local public and private school districts, online schools, and at-home schools.
  - Early STEM Engagement: Partner with middle and high school programs to expose middle and high schoolers to STEM activities, including two to three hours a week of community services that include STEM tutoring services and research project development. Early engagement in STEM activities, including STEM research will help increase students' interest and prepare them for success in STEM programs and careers (Dunbar & O'Connor, 2016).
- **Four-Year Universities**
  - Leverage the resources of local four-year universities to extend STEM students' experiences in undergraduate research and provide seamless transfer opportunities.
    - Articulation Agreements: Establish STEM articulation agreement to develop aligned STEM courses and pathways to ensure transferability.
    - Undergraduate STEM Research Opportunities: First-generation students, from historically underrepresented groups, or lower-income backgrounds are often underrepresented in the accessing quality educational experiences and participation in experiential learning opportunities and research training (Keck et al., 2018). Therefore, community colleges should focus on inclusion and expansion of STEM research training in STEM and scholarships for URMs to ensure the success of URMs beyond the classroom into the workforce.
- **Industry**
  - Aid in creating STEM career identities among URMs through internships, apprenticeships, and career opportunities.
  - Collaborate on STEM Curricula design.

Addressing Institutional Factors

Institutionalizing the initiatives and strategies throughout the campus will help increase intentional faculty engagement and increase engagement of URMs in STEM programs and activities. Leadership must create institutional environments designed to meet the needs and desires of future students (Falk & Blaylock, 2010) and current students, inclusive of URM students.

- **Culture and Climate**
    - Create an institutional culture and climate that supports racial and ethnic diversity as an institutional goal
    - Diversifying STEM Faculty (HR practices)
    - Evaluate and Assess effectiveness of efforts and to hold faculty, staff, and administrators accountable for achieving desired outcomes
- **Professional Development**
    - Implicit Bias and Growth Mindset Training: Growth mindset cannot be one held solely by students. Faculty members and Staff must also recognize the growth potential in all students and remove any stereotypical or bias behavior when teaching students.
- **Teaching and Learning Strategies /Curriculum Design**
    - Multimodal Learning Strategy: using this strategy accommodates multiple learning styles and could help students learn more quickly and connect to the subject area more. Create collaborative and cooperative STEM learning environments
    - Course-Based Research: Integrating undergraduate research into the STEM-related curricula/coursework can improves Faculty-Student Engagement and connects students to the STEM subject.
    - STEM Convergence: Collaborate with fellow Faculty to develop a cross-disciplinary convergence of STEM curricula, e.g., incorporating the writing of short essays in science and engineering classes, graded by English teachers, in collaboration with the science and technology instructors; and integrating data and tools from the physical sciences, life sciences, engineering, and other fields to help better prepare students for a competitive STEM workforce.
- **Federal and State Funding**
    - Aggressively pursue grant funding to support special services or support aimed at enhancing and improving educational experiences for URMs.
- **Faculty Engagement**
    - Actively involve faculty in the decision-making process for changes in STEM curricula, professional development/training, and other activities associated with the engagement, recruitment, and retention of URMs in STEM.
        - Create a Faculty STEM Task Force
        - STEM Research Fellows programs

- Service-Learning Faculty Fellows Retreat
- STEM Faculty-Industry/Community Engagement Projects
- STEM Faculty Recognition

Summary

Community Colleges are essential driving forces that can promote a shared responsibility among stakeholders in increasing the representation of underrepresented populations in STEM education and workforce, including among policymakers, industry, community leaders, K-12 systems, and four-year universities. Establishing a shared responsibility among these key stakeholders could ensure guided STEM pathways and effective teaching and learning strategies that piques and maintain the interest of STEM areas in early educational experiences and warrant success for underrepresented populations from their secondary to postsecondary experience, which in turn, would lead to college access, college readiness, and completion for ALL students regardless of their socioeconomic background, age, or race.

Chapter VI: Implications and Recommendations

Introduction

In the future of student success and educational attainment of URM students in community colleges and workforce, what factors will be considered imperative to ensure URM representation in academia and the workforce? Based on the information derived from qualitative interviews that were conducted for the purpose of this study, there is significant data that identifies barriers and demonstrates which variables impact URM representation as it pertains to STEM education attainment and the workforce. The narratives of those that were interviewed provided valuable information to support the data and experiences of those that advocate for URM representation in STEM and the URM populations themselves.

Underlining and reiterating the significance of the study, addressing barriers through the proposed strategies in Chapter IV. can significantly alter how community colleges prepare and work with underrepresented populations. But if they could strategically institutionalize the PS-MB model, the racial and gender gaps in STEM could possibly narrow, and in turn, help promote and improve economic mobility and income equality. Not implementing these strategies could perhaps leave the development of URMs and racial and gender gaps in STEM stagnant.

Implications of Research and PS-MB Model

It is apparent that the majority of URMs from disadvantaged backgrounds, as identified in the literature and by the participants in the study, need more structured and intentional services than their counterparts because of the effects of the barriers that limit their interest, access, and exposure to quality STEM experiences.

The implications for community colleges increasing the number of URMs in STEM fields through the PS-MB model are two-fold. First, research on the low representation of minorities in these high demand areas emphasizes the urgency of alleviating individual, external, and institutional barriers that make it difficult for URM populations to pursue and advance in STEM. It has been discovered that when URMs, particularly those from impoverished communities and families with low educational attainment, are given the right resources and an opportunity to excel, along with a nurturing support system, they express more interest and perform better in STEM. Because community colleges are in a unique position and currently serve the majority of underserved communities, institutionalizing the PS-MB model and additional reforms can bridge the gap between URMs and non-URMs in STEM.

Secondly, if implemented properly, institutionalizing these practices may enhance teaching and learning strategies in all programs and STEM coursework, which can be tailored to specific courses. These strategies could possibly form a definite culture of inclusion and diversity on community college campuses, and thus, warranting positive outcomes for two-year colleges as they relate to increased enrollment, retention, completion, and four-year transfer rates. Integrating the model could also aid in the colleges creating broader strategies to develop an environment conducive to student success for all students.

Institutionalizing the PS-MB Model

Community colleges can play a pivotal role in increasing the representation of URMs in STEM education and workforce. To achieve this goal, specific needs and barriers should be assessed in order to develop intentional and strategic initiatives. However, these efforts, such as the proposed strategies in the PS-MB model, must align with the overall mission and strategic plan of institutions. This approach, in turn, can help community colleges "institutionalize" sustainability and create a campus culture that reflects inclusion. In changing or transforming a culture of an institution, Kotter's 8 Step to Change model should be considered. Akhtar and Kotter (2019) found Kotter's 8 Steps to Change to be the most effective and essential model for transformational change in institutionalizing strategies. This notion is mainly due to its sequential order of action.

Kotter's 8 Steps to Change Model

1. Sense of Urgency: Identify the Needs
2. Creating a Guiding Coalition: Identify Resources and Strategic Planning Committee
3. Present a Clear Strategic Vision and Initiatives: Outline the Goals and Align the Initiative with strategic plan and priorities
4. Communicate the Vision: Identify Stakeholders and Roles
5. Remove Obstacles: Identify the Barriers
6. Create Short-Term Wins: Develop Solutions to Address the Needs, Goals, and Barriers
7. Build on The Change: Maintain frequent communication and collaboration with stakeholders to sustain momentum.
8. Anchor the Changes in College Culture: Integrate PS-MB model in Strategic Plan (Institutionalized Efforts)

When institutionalizing the PS-MB model through Kotter's 8 Steps to Change in strategic plans, we also recommend addressing barriers from the stances of structural and cultural transformation and a position of strength, including:

- **A faculty and staff dedicated to providing URMs with the support and practical skills and knowledge to thrive through intentional student services, including recruitment and retention to:**

  - Influence inclusion and diversity across campuses and in STEM fields
  - Produce quality educational experiences for underrepresented populations
  - Enable quality instruction programs and teaching and learning strategies
  - Improve graduation rates, productive grade rates, and persistence rates
  - Fulfill the institutions' mission to serve a growing and increasingly diverse URM population
- **Multimodal programs and undergraduate research initiatives that take advantage of current resources, including four-year universities, and STEM/research-related industries that aid in:**
  - Producing more URM graduates with skills their profession demands
  - Allowing more curricula programs to thrive
  - Facilitating the ability of URMs to engage in STEM experiential learning and connect with employers
  - Increasing URMs' transferability to four-year universities
- **Producing more scholarship opportunities to increase college enrollment and accessibility for underrepresented populations to include first-generation and low-income students.**

Colleges should determine or include a strategic planning committee to initiate and effectively implement the model. The committee may include the president, faculty and staff members, including student services, campus administrators, and a budget officer or financial planning representative. We also recommend combining John Kotter's 8 Steps to Change model with John M. Bryson's strategic planning process (Bryson, 2018) for the implementation of the model and to transform the culture of institutions. Bryon's planning steps with our brief recommendations are as follows:

- **STEP 1: Initiate and Agree**
  - Conduct a S.W.O.T. Analysis
  - Initiate the effort
- **STEP 2: Identify the institution's mandates**
  - Identify a Planning Committee

- Ensure Accreditation Requirements

- **Step 3: Clarify the institution's mission and values**
  - Align all initiatives with the mission and values of the college
- **STEP 4: Assess External and Internal Resources**
  - Identify available/current budget and resources and stakeholders (direct and indirect) needed to implement the strategies
- **STEP 5: Identify Strategic Issues**
  - Identifying the Need and Problem
  - Research various case studies and the effectiveness of integrating strategies and its impacts on teaching and learning strategies and the growth and development of URMs
- **STEP 6: Formulate a strategy and plan to manage**
  - Identify best practices and develop clear objectives and desired goals
- **STEP 7: Review and adopt strategies and plan including approval**
  - Review the plan and identify potential barriers and implications and strategies to mitigate them
  - Obtain approval from leadership or authorizing parties
- **STEP 8: Establish effective Vision**
  - Identify metrics and measures to ensure effectiveness, including data review
- **STEP 9: Develop effective implementation process**
  - Implementation
  - Identify appropriate communication strategies
- **STEP 10: Reassess strategies strategic planning process**
  - Review and Evaluation of Data and Progress

Based on prior research and the expertise of key stakeholders in community colleges, four-year institutions, non-profit organizations, and state and national leaders, the research methods used in this study provided suggestions in a narrative and "how-to" format. With this information, community colleges, four-year institutions, and workforce leaders can identify best practices to assist URM populations that have identified and indicated the need for assistance for degree completion, student success and establishing a career in STEM. This study is imperative for community college administrators and faculty, primary and secondary educators, parents, and other constituencies who implement best practices and initiatives to assist URM populations. Although we recommend the strategic steps to systematizing the PS-MB model, we also suggest examining peer colleges that have been recognized for best practices geared toward serving minority populations and glean implementation successes from them.

Modeling the Best Practices of Peers

While community colleges serve different populations and may have developed best practices and strategies to address URM barriers to STEM in their own environments, they should also consider researching the best practices and successes of other colleges in addressing student access and success. A valuable strategy is to view literature that includes evidenced-based results and the examples from recipients of student success-related awards, such as the Aspen Prize represented by the Aspen Institute College Excellence Program, the Malcolm Baldrige Quality Award (MBNQA), and other performance awards. The Aspen award recognizes community colleges for successes, data-driven outcomes, and evidence-based strategies in the areas of learning, completion, post-graduate employment, access and equity for the underserved populations (Aspen Institute, 2020). Established by the U.S. Congress in 1987 to raise awareness of quality management, the MBNQA award recognizes U.S. organizations including business and education for performance excellence (American Society for Quality, 2000). Among several community colleges recognized for their performance and successes in engagement strategies, collaborations, and institutional practices, we recommend that readers review the best practices of St. Philip's College, Manchester Community College, and San

Jacinto College because of their notable strategies. The engagement strategies of the colleges, in conjunction with mentoring initiatives, were found to be key components in navigating individual factors and barriers. Their deliberate partnerships and collaborations exemplified a shared responsibility in combating external barriers, while their institutional reforms removed structural barriers.

A 2019 top 150 Aspen award finalist and the recipient of the 2018 Texas Award for Performance Excellence (TAPE) and 2018 Malcolm Baldrige National Quality award along with its sister colleges of the Alamo Colleges, St. Philip's College (SPC), one of the Alamo Colleges in San Antonio, Texas, offers successful pathways through summer bridge and dual credit programs and an Early College High School (ECHS) program to local high school districts to promote early access and engagement higher education, including STEM and college coursework (SPC, 2020). SPC's ECHS earned a bronze medal for performance on student preparedness (SPC, 2020). St. Philip's also provides STEM-focused community outreach through their Centers of Excellence (COE) for Mathematics and Science with funding through the U.S. Department of Education Title III program; connects female students to potential employers and overcoming obstacles in male-dominated career fields through our Women in Non-Traditional Occupations (WINTO) program; and focuses on attracting both middle and high school students. SPC has an annual enrollment of over 12,000 students that consists of 11.5% African American, 59.8% Hispanic, and 7% of other ethnic groups, and 56.8% women. The college is the only institution in the U.S. with the unique distinction of being officially designated as both a Historically Black College and University (HBCU) and a Hispanic Serving Institution (HSI) (Morris, 2017).

Aligning with early engagement and support services through mentoring initiatives, Manchester Community College (MCC) in Manchester, Connecticut, was a 2015 Aspen prize awardee that was recognized for several institutional efforts and processes, including their mentorship programs, that improved student success and completion rates. In one of the Aspen review sections, Completion Outcomes, MCC's mentoring program for Black and Hispanic students and Summer Training and Academic Retention Service (STARS) were highlighted (MCC, 2020). These specialized mentorship programs are designed to help middle school students, first-year students, and freshmen (especially low-income students, usually first-generation students) succeed.

In efforts to address institutional concerns regarding the academic success rates of Hispanic and African American students, MCC implemented the Brother-2-Brother and Sister-2-Sister mentoring programs to provide additional support, mentoring, and encouragement to this particular population in achieving their educational and career goals. The programs also focus on the holistic development of each student, including social and cultural development (MCC, 2020).

The STARS program reported significant results showing an impressive fall-to-spring retention rate of 88% among the program participants compared to new students and non-STARS participants with an 80% retention rate. It was found that MCC's STEM division also provides mentoring services specifically to their students, but no results were reported.

Also supporting the impacts of mentoring initiatives with evidence-based strategies and outcomes, Kanchewa (2019) reported a successful mentor model at Vanderbilt University (VU) Mentoring Program, a PWI in Nashville, Tennessee, designed with VU college students, primarily white women, mentoring students from low-income and high-poverty high schools with graduation rates below 50%. Kanchewa's study found that while the program impacted the mentees, it also increased the mentors' awareness of social inequities and encouraged their commitment to social justice issues and civic engagement.

San Jacinto College (SJC) in Pasadena, Texas, was recognized as one of top ten finalists in the 2021 national prize competition by the Aspen Institute. The college's innovative practices to mitigate student learning barriers and partnership and collaboration efforts were commended by the Institute (Aspen Institute, 2020). The college offers rigorous workforce programs that directly meet the needs of employers and specific job opportunities identified with the community they serve, including STEM occupations. To promote STEM education and awareness across their region, the college has developed a STEM Council to advance its efforts in securing a shared responsibility by strengthening partnerships with local universities and industries (Aspen Institute, 2020; SJC, 2020).

Along with the St. Philip's College and Manchester College, San Jacinto provides wide-ranging and effective pathways to remove barriers, including unintentional barriers, to completion by providing quality instruction and student-centered initiatives. Although there are many colleges recognized by the Aspen Institute, these three colleges demonstrated a significant focus on the success of minority students through specific engagement strategies, meaningful partnerships, and well-thought-out institutional reforms, including strategic pathways to success.

Even through the institutions' exemplary work, evidenced-based studies and extensive research, the researchers discovered there are still disproportions in providing holistic resolutions to URM barriers to STEM. These disparities are captious to resolving and dismantling continuous hurdles within URM populations. Therefore, we recommend additional investigations that include input from STEM-related industries and URM populations themselves. These recommendations could advance mission and goals of individuals, institutions, and organizations that are committed to cultivating a robust and diverse STEM workforce.

Recommendations for Future Research

Based on the limitations and delimitations described in Chapter III and common ideologies presented in the research study, the researchers identified four recommendations for future work that will also present solutions to mitigate barriers for URM in STEM education and workforce. The recommendations for future research include the following:

Recommendation 1

Compare the results from various constituencies across the United States that provide major contributions to the STEM workforce and education.

The findings of this research study demonstrated common themes of individual, environmental, and institutional barriers among URM populations in regard to education and workforce development. Throughout the research and the interviews, the barriers that were identified were often comparable even though the participants had different occupations, education, and professional backgrounds. Allen-Ramdial and Campbell (2014) describe URM student experiences that have similar backgrounds and stated that "Students who attended the same college, resided in a particular neighborhood, or emigrated from the same geographical region may share common experiences; therefore, often associate early in their educational training to form support groups" (p. 615). A research study that explores the narratives of individuals who reside in one geographic region or work with a singular URM group may provide insight into best practices that could mitigate barriers for all URM populations in STEM.

A study that would examine narratives of constituencies in various regions and within various occupations could demonstrate the commonality of those barriers and, better yet, examine a larger variety of solutions and examples of how these barriers had been mitigated. Based on the geographical region, there may be vast differences in how the barriers and needs of URM populations are observed and addressed.

Recommendation 2

Identify best practices for mitigating barriers from the URM student's perspective.

While several research studies provide examples and narratives of URM students' perceived barriers and approaches to meet their educational and psychological needs, more research is needed that examines the impact of specific best practices on students' educational and workforce development from the students' perspective. This research could follow the educational path of several students to explore their lived experiences. A study with these goals could mirror the work of Allen-Ramdial & Campbell (2014) that addressed the "leaky" pipeline, the unintentional loss of trainees within STEM disciplines because of the lack of consideration and focus on the barriers faced by the individuals.

Through their stories, students' voices could provide authenticity and intensity to the gravity of the need and identify solutions for URM populations in STEM. This research study would ignite future discussions about the best practices and solidify the value of resources and investment of initiatives designed to create opportunities and contribute to the success of URM students in education and continue to employment attainment.

Recommendation 3

Track and interview URM STEM graduates to detect barriers in their attainment of STEM positions.

Considering the delimitations that were identified for this study, future steps could include interviewing representatives from top STEM-related companies, such as BOEING, Google, and Apple to diagnose barriers to recruiting and retaining URMs in STEM careers. Ranging from Silicon Valley to the Hudson Valley, there are distinct differences among companies in hiring practices and deliberate goals to diversify their staff. A study could examine whether distinctions exist based on regional location and what recruitment and retention practices advance the representation and success of URMs in STEM. This study should include interviewing and surveying STEM-related employers to identify and research the impact of hiring best-practices for URM STEM graduates.

Research conducted as recently as 2018 by Funk and Parker outlines discrimination of one particular URM population in STEM occupations. However, there are other reports and research studies that focus on the experiences of other URM populations in STEM industry positions. For example, Quillian et al. (2017) completed a meta-analysis of callback rates from 24 field experiments that included data from over 54,000 applications across more than 25,000 positions. The analysis revealed evidence of discrimination against both Latino and Black applicants. According to the study, since the 1990s, white applicants received over 36% more callbacks than Black applicants and 24% more callbacks than Latino applicants with identical résumés (Quillian et. al, 2017). The study also showed the hiring gap between whites and Blacks has not changed in 25 years. It does show a small decline in the hiring gap between whites and Latinos. However, the data does not identify if the discrimination was influenced by the occupational groups, local labor market conditions, education, or gender.

Future work would be critical to industry and workforce leaders to bring awareness to past and present examples that hinder URM populations from advancing in STEM fields but also provide examples of ways that industries can implement hiring best practices and provide diversity training to hiring managers, which would be pivotal in the success of URMs in the workforce.

An additional study could also follow a group of URM students who have recently graduated within a STEM field of study and examine their obstacles in securing a job in a STEM-related field. Did the students feel academically prepared and welcomed within the field? Were the barriers identified in the research study dissipate or continue in the transition to the workforce? Did the students recognize or feel blatant disparities and discrimination in the hiring practices within the industry?

Unfortunately, many of the identified barriers of this research study continue to affect URM students beyond graduation. The findings from the recommended studies could provide college faculty and staff, future students, and industry leaders an intimate perspective to the adversity of how those barriers affect URM populations in employment attainment. Again, once the barriers have been identified, those in supportive roles can entwine additional best practices to mitigate those barriers related to job readiness and inclusion in STEM.

Although there are several avenues to conduct data-based research on URM populations, it is imperative to continue qualitative research that will continue to raise awareness and understanding for the URM voices.

Reflections and Conclusion

Many leaders and administrators have begun the footwork towards allocating resources and providing support towards student success for URM students. Initiatives and support services, such as the Louis Stokes Alliances for Minority Participation and TRiO federal programs, have been established to increase the academic success of underrepresented students. The challenge of ensuring equitable student success outcomes, given the increasing demographic diversity of the students attending community colleges, requires a leadership that can effectively respond. It is imperative for America's college administration and workforce leaders to use methods of motivation, self-determination, and stimulation, to motivate key stakeholders, such as board members, faculty, staff, parents, and students to see the value of investing in such resources and support.

Continued support and success of URM populations within STEM education and workforce areas is a topic that motivates and inspires many researchers, including the co-authors of this study, to continue to advocate for resources to break down these barriers. The researchers experienced and overcame similar barriers and challenges as they pursued their careers. These experiences led them to their shared interest and passion and prompted their need to identify and share knowledge with other researchers so they, and the other scholars who follow them, will continue to address the barriers to success that have risen from the history, cultures, and geographic locations of URMs across the country. The researchers recognize that community colleges can provide the key by developing and offering high-quality educational experiences and STEM-based programs and projects designed to address and eradicate these long-existing barriers. With well-informed and well-designed programs, we can remove barriers to success for underrepresented minorities in STEM — and all — education and careers.

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Appendix A: IRB Approval Letter

FERRIS STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD FOR HUMAN SUBJECT RESEARCH
1010 Campus Drive FLITE 410 Big Rapids, MI 49307 | (231) 591-2553 | www.ferris.edu/irb

Date: July 14, 2020

To: Susan DeCamillis, Tomeka Cross, Shani Newton
From: Gregory Wellman, R.Ph, Ph.D, IRB Chair
Re: IRB Application *IRB-FY19-20-201 Identifying and Mitigating Barriers to Increase Underrepresented Populations in STEM Education and Workforce*

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, *Identifying and Mitigating Barriers to Increase Underrepresented Populations in STEM Education and Workforce(IRB-FY19-20-201)* and approved this project under Federal Regulations Exempt Category 2.(iii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Your protocol has been assigned project number IRB-FY19-20-201. Approval mandates that you follow all University policy and procedures, in addition to applicable governmental regulations. Approval applies only to the activities described in the protocol submission; should revisions need to be made, all materials must be approved by the IRB prior to initiation. In addition, the IRB must be made aware of any serious and unexpected and/or unanticipated adverse events as well as complaints and non-compliance issues.

This project has been granted a waiver of consent documentation; signatures of participants need not be collected. Although not documented, informed consent is a process beginning with a description of the study and participant rights, with the assurance of participant understanding. Informed consent must be provided, even when documentation is waived, and continue throughout the study.

As mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) the IRB requires submission of annual status reports during the life of the research project and a Final Report Form upon study completion. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.

Regards,

Gregory Wellman, R.Ph, Ph.D, IRB Chair
Ferris State University Institutional Review Board