# UNDERREPRESENTED MINORITIES IN COMMUNITY COLLEGE STEM (SCIENCE, TECHNOLOGY, ENGINEERING, MATH) PROGRAMS: A PHENOMENOLOGICAL STUDY BASED ON THE VOICES OF COMMUNITY COLLEGE STEM GRADUATES

by

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ABSTRACT

This phenomenological study describes the lived experiences of underrepresented minorities (URMs) who graduated from a community college with a STEM (Science, Technology, Engineering, Math) degree or certificate. In this research, underrepresented minorities are defined as African American, American Indians, and Hispanics. The research was guided by three major questions: What is the developmental math experience of the underrepresented minority (URM) students who graduated from a community college with a Science, Technology, Engineering, and Math (STEM) degree or certificate? What are the lived experiences of URM STEM students? And how do URM STEM students find meaning in completing STEM programs at community colleges?

Since the early 1970s, programs have been created – from pre-college to college — specifically to increase underrepresented minority participation in STEM fields, yet minorities continue to lag in degree attainment in STEM programs. In that community colleges enroll 51% of undergraduate Hispanic students, 44% of African Americans, and 54% percent of all Native Americans, the community college pathway is a viable option to increasing minority STEM graduates. By examining the experiences of the participants in this study, nine themes emerged: instructors, tutoring, peer mentoring, co-op/money, motivation/belief in self, community engagement, race, small class size, and giving back. The researcher discussed seven components of leadership that will help increase the

number of URM students that enter STEM programs at the community college level: cultural competency, communication skills, holistic approach, multi-dimensional approach, community engagement, committed resources, and the courage to lead.

This work is dedicated to my mother, Tommie Moore, who pushed me to be a servant to others, and to my dad, the late Jethroe Moore, who offered me a global perspective of life by exposing me to the world at a very young age. I love you both very much.

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# INTRODUCTION TO THE STUDY

"Culturally sensitive academic and support activities especially designed to provide a sense of welcome and belonging, to motivate and empower, and to make knowledge meaningful and accessible to ethnically diverse students remain crucial to community colleges…"

Laden, 2006, p. 422

## Introduction

Numerous reports, conferences, policy makers, educators, and scholars have conveyed concerns about the need for the U.S. to prepare students for science, technology, engineering, and math (STEM) careers (Obama, 2009; Leach, 2010; Tsapogas, 2004; Barber, 2011; Gandara, 2006; Huang, 2000; National Academies, 2010; National Science Board, 2010; U.S. Department of Labor, 2007; Elliott, et al., 1996; Quimbita, 1991; Lowell & Salzman, 2007; Expanding Underrepresented Minority Participation, 2011). Some of the concerns are born out of the fear that the United States is falling behind in its world position as the dominant power in innovation and technology predicated on several factors: a STEM workforce shortage, achievement gaps, and low STEM performance and access of cultural and ethnic groups-specifically underrepresented minorities (URMs) (Lowell & Salzman, 2007). The URMs generally referenced with concerns are African Americans, Hispanics, and Native Americans, who are the focus of this research. This is not a new problem. Since the late 1960s to early 1970s, various programs have been created—from precollege to college—specifically to

increase URM participation in STEM fields (Leggon, 2006; Clewell, Anderson, & Thorpe, 1992), yet in 2013 gaps continue to exist for underserved populations who earn significantly fewer STEM degrees than white and Asian students (Coleman, Lipper, Keith, Chubin, & Taylor, 2012). There are hundreds of STEM programs sponsored by federal, state, and local government agencies, educational institutions, and private philanthropic organizations. Many of these efforts are short-term, disconnected, and motivated by self-interest. These efforts, though commendable, still have not closed the achievement gap for URM student degree attainment in STEM.

Although women are an underrepresented group in STEM fields in this country, research indicates that URM women and men in general have similar STEM college experiences (Reyes, 2011) and the importance of parity for the identified URM groups is unparallel at this time. In that URMs are projected to be the largest growing demographic population in the country (Expanding Underrepresented Minority Participation, 2011; NGA Center for Best Practices, 2011), this is a critical issue that affects colleges and universities, state and federal governments, corporations, and other stakeholders that are invested in the economic and intellectual growth of the United States.

## Experiences of the Author of this Study

Self-reflection is part of the validity process of a qualitative research study. Self-reflection requires that the researcher examine personal assumptions, beliefs, and values. A personal assumption of the researcher is that community colleges are addressing the needs of ethnically diverse students and fulfilling their missions. The researcher agrees with Laden (1999) that "Culturally sensitive academic and support activities especially designed to provide a sense of welcome and belonging, to motivate and empower, and to

make knowledge meaningful and accessible to ethnically diverse students remain crucial to community colleges . . .” (p. 422). Furthermore, a community college with an inclusive environment that is committed to serving the community in which it is located is a core belief of this researcher. This core belief is central to the foundation of the community college mission, which is to provide access to an affordable higher education to those who desire it. This researcher values the philosophy of the open door– that everyone can, through education, achieve his or her academic, career, and personal goals (Myran, 2009).

The researcher of this study has more than 20 years of higher education experience in private universities, public universities, and community colleges. The cumulative years of working in higher education have prepared this researcher to provide leadership in counseling, advising, career services, student engagement, multicultural services, minority student services, and diversity and inclusion programs. Other areas of expertise are human resources, affirmative action, title IX compliance and equity. The researcher has extensive experience serving on college committees, which demonstrates knowledge of shared governance, collaborations, partnerships, and teamwork that spans across many departments and divisions internally at the college and externally in the community. Both the community and the college have recognized the academic and community achievements of this researcher as indicated in the following examples: received the Delta College 2012 Sungard Endowed Teaching Chair; received the Bay City, Michigan Branch of the National Association for the Advancement of Colored People (NAACP) Diversity Award in 2011; awarded the Wenrich Scholarship for the Ferris State University Doctorate in Community College Leadership program, 2010-

2013; received the Saginaw, Michigan Branch of the NAACP Community Service Award, 2006; the Bay Mitten Girl Scouts Women of Distinction designation in 2005, and The Liberal Arts Network for Development (LAND) Team Award for Excellence in Institutional Leadership in 2005.

As a student in the Ferris State University Doctorate in Community College Leadership Program, the researcher has become more aware of the multiple roles of community colleges and the processes associated with advocating and advancing the mission, developing and executing strategy, and driving institutional effectiveness for the success of community colleges. As a mid-level manager at a community college, the researcher has experience in developing and managing programs as well as establishing and maintaining collegial partnerships that focus on diverse student populations and staff.

With a keen understanding that collaborative relationships and partnerships help build strong communities, actively engaging the community plays a significant role in this researcher's life. As is the case with many community colleges, one critical challenge is effectively meeting and managing the needs of the community in which the college is located. Swan (2009) writes that "Community engagement is the community college's approach to public leadership that uses the college's education resources to solve problems in cooperation with citizens and other organizations" (p. 68). With that being so, this researcher has "woven together" aspects of her job by being involved in the community through a variety of community organizations and activities that include outreach efforts for the college. For example, in 2011, the researcher was successful in securing her college as the location for the first Regional Dr. Martin Luther King, Jr. Youth Symposium for area schools, which 500 students attended. As chair of the

colleges' Student Leadership Academy for five years, the researcher worked collaboratively with faculty and staff to engage students in the development of leadership competencies based on Kouzes and Posner's book *The Student Leadership Challenge* (2008).

When talking with URM students about their career choices, this researcher has observed that many are choosing to study social work, psychology, or business curricula; it is rare to hear of a STEM career as a choice. It is not rare to listen to students who, frustrated with their math classes, check with this researcher to learn of academic majors that require little math or no math at all. This researcher's personal experience is similar to many students who become frustrated with math to the point of changing majors. As an undergraduate student, this researcher started out as an accounting major, did not do well in a math class, and therefore changed to the psychology curriculum. It was through the challenges in math that this researcher met her husband, who has a bachelor's degree in chemistry, while being tutored for math in the science building on campus in undergraduate school. This researcher has attended many conferences and meetings with her husband, hearing many lectures, speakers, and symposiums on the topic of the low number of underrepresented minorities in STEM curricula and careers, and finds it curious that over the years, the discussion has not changed significantly.

## The Importance of this Study

According to the American Association of Community Colleges (AACC, 2013b), community colleges enroll 51% of undergraduate Hispanic students, 44% of African Americans, and 54% of all Native Americans. Although much of the data and research around the low minority participation in undergraduate STEM programs are focused on

the attainment of bachelor's degrees or higher, the National Science Foundation reports that 50% of African Americans, 55% of Latinos, and 64% of American Indians who hold bachelor's or master's degrees in science or engineering attended a community college at some point in their educational journey (as cited in Tsapogas, 2012). Reports issued by the *Science and Engineering Indicators* (2012) and the *Science and Engineering Indicators Digest* (2012) indicate that in 2009, URMs earned 28% of science and engineering associate's degrees. Of special not also in this report is that in 2009, URMs earned "more than one quarter of all associate's degrees in biological sciences, computer sciences, and mathematics" (*Science and Engineering Indicators,* 2012). Other statistics from the *Science and Engineering Indicator* (2012) show that during the years 2005-2009, of the 17,033 science and engineering doctorate recipients who reported earning community college or two-year college credit, 122 were American Indian/Alaskan Native, 706 were Black/African American, and 1,024 were Hispanic, which combined is 1% of the doctorates earned. These statistics are significant and presents an opportunity for community colleges to reach more URM students who could potentially consider a STEM career. And so the question is: What is the experience of the URM students who completed a community college STEM curriculum?

Freeman Hrabowski, president of the University of Maryland–Baltimore County, and others, have observed that the population demographics in the United States are shifting and URM groups make up the majority of the K-12 school-age children who are eligible to attend college (as cited in Tsapogas, 2012). With the open door/open access mission of community colleges, and the high enrollment of URM groups, this researcher

contends that community colleges are the logical pathway to strengthening and increasing participation of these groups in the STEM pipeline.

Strong and visionary leadership is needed to help guide and prepare these students for careers in STEM, and community colleges are well positioned to lead this incredible journey that can strengthen the pipeline of underrepresented minorities in academic preparation for STEM careers

## Definition of STEM

What is STEM? A most interesting point about STEM careers is the fact that there are a number of discipline options to choose from such as astronomy, chemistry, computer science, engineering, environmental science, geosciences, life sciences, physics, and mathematics. In addition to these obvious career choices, within these disciplines are a broad range of occupations such as biochemical engineers within the chemistry discipline; graphic designers within the computer science discipline; transportation planners within the engineering discipline; and risk management specialists within the mathematics discipline.

For this research, STEM is defined as follows: Science refers to careers in which experiments are designed to find out how things work; technology refers to those careers within computer-related occupations; engineering refers to those careers that design, develop, and test products; and math refers to those careers that develop theories and tools to solve problems. STEM careers require a good understanding and comprehension of mathematics, which is the core of all STEM majors (Laanan, 2012). Having a competent and competitive STEM workforce is critical to the scientific and technological leadership of the United States as a global power. In that most STEM careers use science

and math to solve problems, these occupations develop most of the new products and make most of the new discoveries in the world (Terrell, 2007). Community colleges can help build and sustain this leadership.

In a 2011 brief, the NGA Center for Best Practices pointed out that STEM professionals in computer engineering, mathematicians, software designers, engineers and technicians in the life and physical sciences are in high demand. The brief also predicts that there will be more than 8 million jobs in STEM (with nearly half available through retirements) by the year 2018. These jobs will go to college graduates. The options for securing employment within a STEM discipline are impressive, and effective, 21st century sustainable programs designed to prepare URMs for these jobs are needed.

## History of Minority STEM Programs

Since the late 1960s, there have been abundant funding mechanisms for precollege and college URM STEM programs available, specifically from federal agencies such as the National Science Foundation, National Institute of Health and NASA, and nonprofits such as the Ford and Sloan foundations (Leggon & Pearson, 2006). Arcidiacono, Aucejo, and Spenner (2011) write that the National Science Foundation (NSF) has spent more than $1.5 billion to increase minority participation in the sciences (p. 30). Two programs of the National Institute of Health (NIH) have spent more than $675 million on programs to increase minority participation in the sciences (p. 30). A significant number of the STEM programs that came out of the 1960s were based in urban areas, including Detroit, Michigan; Washington, DC; and Berkley, California, as well as states such as New York, Florida, Georgia, and North Carolina**.** Three of these programs are described below:

1. In the late 1960s the Mathematics, Engineering, Science Achievement (MESA) program began when a group of university professors, schoolteachers, students, and other professionals became concerned with the small enrollment of Mexican Americans, Blacks, Native Americans, and Puerto Ricans in the engineering program at University of California, Berkley. This state-funded program was designed to help students complete three to four years of high school math.
2. The Detroit Area Precollege Engineering Program (DAPCEP), which started in 1976, was initially funded with a grant from the Alfred P. Sloan Foundation, a philanthropic, not-for-profit grant-making institution established in 1934 that is based in New York City (Hill et al., 1990). The purpose of DAPCEP was to increase the number of minority students–specifically Black, Hispanic, and Native American–who were prepared academically to enter into engineering and technical disciplines. DAPCEP was collaboration between the University of Michigan, Michigan State University, one Detroit high school, and two middle schools (Clewell, Anderson, & Thorpe, 1992).
3. In 1985, the Mathematics, Science, and Minorities, K-6 was developed to involve all of the school districts in Washington, DC. The goal of the program was to increase the participation of Black and Hispanic students in math and science through school-based teams. Clewell et al. (1992) write that this program recognized math as a "critical filter to sustaining participation in science" (p. 229).

Although all of the programs listed above are considered successful, the number of URMs in STEM careers continues to lag.

Due to budget restraints of the earlier funding of STEM programs designed specifically for URMs, the evaluative piece–or evidence to support success in the programs–was lacking (Leggon & Pearson, 2006). There is still concern with program evaluation today. However, with the American Association of Community Colleges' (AACC) new Voluntary Framework of Accountability (VFA) standards from the Community College Completion Agenda, the opportunity exists to "measure student outcomes and performance." This creates a unique benefit to the role that community colleges can play in increasing and strengthening the STEM pipeline for URMs today and into the future.

As funding remained available and the programs grew, it was still evident that minority participation in STEM programs and degree attainment lagged behind that of White and Asian males. According to the 2010 report, *Expanding Underrepresented Minority Participation,* underrepresented minorities "embody a vastly underused resource and a lost opportunity for meeting our nation's technology needs" (pp. 1-2). The impact of this situation has resulted in a significant challenge for the U.S. to prepare and nurture URM talent to enter STEM careers, yet, at the same time presents an opportunity for community colleges to provide leadership. In his book *Reinventing the Open Door: Transformational Strategies for Community Colleges*, Myran (2009) writes that "During the 1960's, community colleges experienced major growth and also opened the door of educational opportunity to groups that had historically been excluded" (p. 3). President Barack Obama has stated that "Science is more essential for our prosperity, our security,

our health, our environment, and our quality of life than it has ever been . . .” (April, 2009). This is a decisive time once more for community colleges to play a vital role in providing educational opportunities for underrepresented groups who have been excluded from STEM careers.

Lowell and Salzman (2007) do not agree that there is a STEM shortage or crisis in the U.S. pipeline, or that because of its ranking in math and science the U.S. is in danger of losing its position as a world leader in innovation. On the contrary, they believe that the data used to make such assertions is questionable and the tests used to determine the rankings have serious limitations in design, implementation, and interpretation of the data. However, there is one point on which Lowell and Salzman agree concerning a shortage in STEM degrees and workers and that is for “domestic minority groups” (p. 5). Lowell and Salzman (2007) assert that their analysis of the math and science data may not apply to this group because the challenges faced by minority and immigrant populations are a result of differences in the educational system in diverse communities. Therefore, they conclude (2007) that based on other barriers to education that expanding math and science education will not address, there is a need for “targeted educational improvements” to serve minority and immigrant groups.

Indeed, there is a wealth of information about the need for STEM academic and career preparation of students in the United States, and other scholars recognize that the need is warranted, but the problem may be overstated (Hagedorn & Purnamasari, 2012). These scholars posit that there are potentially three reasons for this lag in STEM degree attainment for all students in the United States:

- Employers are not hiring graduates of STEM programs because they feel the students are not prepared for the jobs available.
- Students are choosing not to major in STEM careers.
- Students who graduate with STEM degrees are choosing to work in non-STEM fields.

Significantly, even in this position, once more there is agreement concerning the academic achievement gap and lack of progress in STEM careers within underrepresented minority groups–African Americans, Hispanics &and Native Americans. This achievement gap is a challenge to the goal of increasing minority participation in STEM and is deeply rooted in community college discussions and conversations about equity, diversity, access, the open door, and what some describe as an educational crisis level for minorities. The American Association of Community Colleges' *Reclaiming the American Dream: A Report from the 21st Century on the Future of Community Colleges* (2012) acknowledges that community college leaders must address this degree attainment gap "across groups" that is unacceptable. This will require several institutional changes, one of which is a "focus from tolerance of achievement gaps to eradicating achievement gaps." Overall, this change encompasses a commitment to equity, and eliminating attainment gaps associated with income, race, ethnicity, and gender. The goal is not only to increase the quantity of URMs, but also the quality. This critical challenge to community colleges is important to increasing URMs in STEM careers.

There is another side to the debate concerning URMs in STEM programs–most notably at the bachelor's degree level and beyond. A Bayer-commissioned survey of 200

universities in the U.S. revealed that 40% of women of color in STEM programs were told that they would not be successful in a STEM career (as cited in Dorothy, 2012). Studies on Native Americans indicate that they are the lowest URM group for pursuing and completing a postsecondary education. In the Fall 2012 Hispanic Engineer & Information Technology, Dowd states that "Latino students who earn associates degrees in community colleges are very, very unlikely to graduate with a bachelor's degree in STEM . . . [and] to get a STEM bachelor's degree is the toughest thing of all" (Green, p. 14). In Florida, a state with a high Hispanic population, associate's degrees were first earned by almost half of those awarded bachelor's degree in STEM (Dowd, 2012).

Arguably, there are a broad range of STEM careers, which adds a dimension of complexity to increasing URMs in STEM; however, we do know that math is the gateway course for STEM academic curricula and careers. The 2010 study by the National Academy of Sciences *Expanding Underrepresented Minority Participation* offers general parameters for STEM knowledge as it relates to math: basic facts and algorithms, algebra, trigonometry, geometry, problem-solving ability, and verbal skills (p. 241). Studies point out that there are racial disparities in math skills of many underrepresented minorities who enter colleges because of their attending failing and segregated public school systems (Levine, 2011; Boggs, 2011; Frakenberg, 2011). Research by Hanson (2009) indicates that many minority students attend "low-resource" schools, and are more likely to be unprepared and less interested in math and science because of "economic inequality, residential segregation, and often inadequate urban school (and science education) systems" (Jaschk, 2009, para 5). It is for these and other reasons Hanson suggests that colleges (and universities) reach out to high schools to start

mentoring and preparing minority students for their transition to college. However, the reality is that many of these students enroll in community colleges, and we meet them where they are.

A study conducted by the National Center for Education Statistics (2001) found that 42% of community college students are not prepared for college. A 2012 report issued by the Center for Community College Student Engagement (CCCSE) stated that 66% of the students who responded to their survey indicated that they needed developmental coursework in at least one area. Other research indicates that while most students who attend community colleges enroll in some type of developmental educational course, minority students –specifically African American and Latino–are disproportionately enrolled in these courses. The College Board (1990) reported that math and science comprise the biggest academic achievement gap between underrepresented minority students and White students. With the high enrollment of URM students in community colleges, coupled with this group being the "fastest growing sector of the population" (Institute for Higher Education Policy 2012), implementing STEM strategies that have a proven track record of success can be an effective way to increase minority participation in STEM careers at the community college level.

## Community Engagement

*"The work of the engaged institution is responsive to (and respectful of) community-identified needs, opportunities, and goals in ways that are appropriate to the campus' mission and academic strengths."*

One effective way to increase minority participation in STEM is to engage the community being served by the community college. What is community engagement, and

why is this part of the discussion regarding URMs and STEM programs? There are several definitions and variations of community engagement depending on the industry: business, medical, cultural, or educational. A review of the literature indicates six key definitions germane to this research as indicated in Table 1.

Table 1: Community Engagement Definitions

- **Community engagement — public broadcasting (National Center for Media Engagement, 2010**)

  A strategic approach that includes all aspects of a station's work. Multiple projects connect to an overall mission to improve the civic health of the community and increase the station's local significance as a community institution. The station has ongoing conversations with multiple segments of the community, using what they hear to guide decision-making.

- **Community engagement — Grand Valley State University, Grand Rapids, Michigan (2012)**

  - Community engagement is about connecting with those around us to build communities of lifelong learners. It's about connecting the great things happening on campus with the great things going on in our communities.

- **Community engagement — Wingspread conference (Holland, Percy & Zimpher, 2004)**

  Community engagement is colleges and universities strengthening their teaching, research, and service missions through active and collaborative partnerships with their neighborhoods, communities, and regions.

- **Community engagement — African American scholars (Evans, 2009)**

  Communities are central in articulating definitions of social problems and in attempts to solve those problems; people learn better in collaborative communities where everyone is recognized as a learner and a teacher, and that race dialogue is central to healthy or productive communication about change and justice.

- **Community engagement — (Swan, 2009)**

  Community engagement is the community college's approach to public leadership that uses the college's education resources to solve problems in cooperation with citizens and other organizations.

- **Community engagement — (Carnegie Foundation, 2010)**

  Community engagement is collaboration between institutions of higher education and their larger communities for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity.

The open door policy of community colleges allows educational access to students from diverse backgrounds and communities and offers an opportunity for collaborations, partnerships, and special programming that can benefit both the college and the community (Holoman, p. 1, 2009). This idea, described by Myran (2009) as *Community Engagement,* is a new emerging community college open door model. The lag in URM STEM degree attainment in the United States has already had an adverse effect on the innovative and economic growth, and stability of many urban and minority communities. In fostering the philosophy that the community college is engaged with the community in which it is located through collaborations and partnerships, the social, cultural, and economic problems that create barriers to success for URM students will be addressed as well as the needs of the community (Holoman, 2009).

In mainstream American culture, community engagement is somewhat compartmentalized as distinct from everyday events of life (Evans et al., 2009). For African Americans, American Indians, and Hispanics (URMs), community engagement is a way of life. For example, if you compare the definition of community engagement from the perspective of the African American scholar with that of mainstream educational scholars—such as the Carnegie Foundation, George Swan, or the Wingspread conference noted above (see Table 1) –race is not explicitly identified as a part of the definition. This is an important distinction for the following reason:

> Knowing how groups differ in their approaches to solving problems can be of benefit for two reasons. First, it can help us learn important things about the relationship between socialization and problem-solving approaches. This information can guide in the development of pluralistic education programs.

> Second, knowing more about the ways different groups approach problems can lead to the development of improved predictors of success for minority groups (Kapan & Saccuzzo, 1989, p. 501).

Community engagement helps to develop partnerships and collaborations within communities served by the community college and include K-12 systems, service clubs, philanthropic organizations, fraternities and sororities, federal grant agencies, and businesses. Although many community colleges are **in** the community, they are often not **of** the community (Holoman, 2009). When it comes to STEM education, everyone in the community has to be involved in preparing URMs for participation in STEM, and community colleges must lead the way.

## The Purpose of the Study

*"This experience in general, I would say, it basically changed my life."*

- *African American female participant*

The purpose of this phenomenological study is to describe the lived experiences of eight underrepresented minority STEM students. URM STEM students who attain a degree at community colleges are rare, representing "one-tenth of the college-educated science and engineering workforce" (Hanover Research, 2012).

Data from a report released by The National Action Council of Minorities in Engineering (NACME) indicate that across all ethnicities and races, more than half of the associate's degrees awarded in the U.S are in non-STEM areas (Frehil, et al., 2008). For URMs, the number of non-STEM associate's degrees awarded is even higher, as shown in Table 2.

Table 2: Associate's Degrees Earned by Race/Ethnicity, 2005

| ASSOC. DEGREES | AI/AN | A/PI | AA | HISPANIC | WHITE | OTHER | TEMP | TOTAL |
|---|---|---|---|---|---|---|---|---|
| Engineering | 28 | 136 | 162 | 201 | 1,342 | 83 | 120 | 2,072 |
| Science/ Engineering Technologies | 732 | 2,647 | 8,365 | 6,638 | 55,099 | 3,099 | 833 | 77,413 |
| Natural Sciences | 955 | 4,363 | 10,148 | 7,322 | 65,998 | 4,418 | 1,783 | 94,987 |
| Other degrees | 5,344 | 22,636 | 53,891 | 54,044 | 294,763 | 24,780 | 10,980 | 466,438 |
| Totals | 7,059 | 29,782 | 72,566 | 68,205 | 417,202 | 32,380 | 13,716 | 640,910 |

*Source: Confronting the New American Dilemma, NACME, 2008*

**Key to Table 2**

AI/AN = American Indian/Alaskan Native
A/PI = Asian/Pacific Islander
AA = African American
Other = Unknown races or ethnicities
Temp = Temporary resident

Other Degrees include:
Business and Management, Social Service Professions and related, Education, Social and Behavioral Sciences.

Additional research by scholars indicate that 55% of current STEM jobs are occupied by white males–and 26% of this population is older than 50 (Coleman, Lipper, Keith, Chubin, & Taylor, 2012). The next few years will offer tremendous career opportunities to all STEM graduates, but an even greater opportunity to engage students of color–the population found at community colleges (Reyes, 2011) in considering a STEM career.

The focus of this study is to find meaning in the community college STEM journey of participants as told to the researcher in face-to-face or telephone interviews and is based on the individual memories of the students' experiences. This perspective generated dialogue of stories that articulated students' interactions and relationships as a STEM student in a community college environment. The meaning of the experience is defined by the essence of the lived experiences. Essence is the "condition or quality

without which a thing would not be what it is: 'the final truth'." (Moustakes, 1995). The strategy of inquiry includes phenomenological reflection on data shared in the investigation of the students' experiences, and the meaning. Additionally, this research considered the institutional context of the URM student experience in community colleges, rather than the individual student deficit factors.

## Research Questions

This study contends that community colleges are a natural pathway to increase minority STEM graduates. It examined the meaning of students' experiences in order to develop a perspective of underrepresented minority groups through interviews guided by the following research questions: What are the lived experiences of URM STEM students? How do URM STEM students find meaning in completing STEM programs at community colleges? How do URM graduates describe their SEM experience at a community college?

In order to support the primary question, the following sub-questions are considered:

1. What themes emerged in the interviews that support the lived experiences?
2. What underlying beliefs came out of the themes based on the interpretation of the themes?

Other questions considered by the researcher were the following:

1. How do select URM graduates describe community colleges' collaborations with their communities to strengthen scientific literacy in the U.S. of underrepresented minority groups?

2. How do race and degree attainment intersect with select URM graduate STEM experiences at community colleges?
3. What is the framework for creating a STEM model for underrepresented minorities in community colleges?

The quantitative focus sought to answer one question: What is the developmental math experience of the URM students who graduated from a community college with a STEM degree or certificate? The purpose of the survey was to broaden the understanding of the research question concerning the math experience of URM students who completed a STEM curriculum.

Community colleges are a vital part of the economic stability, growth, and viability of the United States, but fewer than half of the students who enter community colleges attain an associate's degree or certificate within six years. The numbers are even lower for underrepresented minority students of color (Achieving the Dream, 2013). Increasing minority participation in STEM programs at community colleges is about student success.

## Methodology

This research involved a study of underrepresented minority STEM graduates. The participants in this study met the following criteria:

- A member of one of the following ethnic/racial groups: African American, American Indian or Hispanic/Latino, and
- Currently working in a STEM or STEM-related career.
- Completed a STEM program at a community college.

Participants for this study were selected in one of two ways: By contacting select community colleges that offer STEM programs interested in increasing minority student graduates from the programs, or by contacting organizations whose primary membership are the identified affinity groups with a mission of STEM professional development in STEM careers. Each contact was asked to identify three to four individuals from the identified minority groups to participate in the study. The goal of this qualitative research is to describe the shared experience of URM community college graduates to uncover and interpret how the participants found meaning in their STEM experience. The assumption is that there is an essence to shared experiences (Merriam, 2009, p. 25). In conducting the interviews and analyzing the data, the researcher was the primary research instrument.

## Key Terms and Additional Definitions

Several terms are used throughout this study. In order to have a clear understanding of the terms, below are definitions:

- Achievement gap: The difference in academic achievement between White and URM students–African-American, American Indian, Hispanic/Latino.
- African American: A person having origins in any of the Black racial groups of Africa (Center for Disease Control and Prevention, 2013) living and raised in the United States.
- American Indian: A person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment (Center for Disease Control and Prevention, 2013) living and raised in the United States.

- Hispanics/Latinos: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race (Center for Disease Control and Prevention, 2013) living and raised in the United States.
- Community engagement: "Communities are central in articulating definitions of social problems and in attempts to solve those problems; people learn better in collaborative communities where everyone is recognized as a learner and a teacher, and that race dialogue is central to healthy or productive communication about change and justice" (Evans, 2009).
- Developmental math: "Organized efforts to develop the cognitive and affective talents that describe the whole student . . . and describes any and all below college-level courses . . . [Including] all forms of learning assistance, tutoring, mentoring, supplemental instruction, personal/career counseling, and academic advising" (The White Paper Group, 2007, p. 12).
- Ethnicity: Consists of cultural characteristics (such as language, history, values, and customs) that are shared by and distinctive of a group of people (Chegg, 2013).
- Intersectionality: In this study, intersectionality is defined as the ways in which race and STEM interact to shape the educational experience of URM students at all age levels.
- Multiracial democracy: Recognizes the distinct histories and related conditions of racial populations in the United States and related conditions that yet remain before the nation is to achieve racial equality (Ivery & Bassett, p. 134, 2011).

- Participant: Used to describe the individuals interviewed for the study, and implies a willingness to cooperate and be included in the study (Merriam, 2009, p. 162).
- Pathway: A way to degree attainment that can include dropping out of high school and later attaining a GED, delaying college entry, initially enrolling part time in college, transferring from one college to another, stopping out of college and returning several years later, managing probation terms, and/or working while attending college (College Board Advocacy & Policy Center, p. 6, 2010).
- Peer mentor: A fellow student who is skilled in providing support, both academic and personal, to other students**.** A peer mentor meets the needs of a specific population, and is usually a student who has been through a specific course or program and has often faced and overcome many of the same challenges that the current students face (City College of San Francisco, 2013).
- Race: A group of people thought to share certain distinctive physical characteristics, such as facial structure or skin color. It is socially constructed as "there is no clear sociologically relevant genetic difference between people of different 'races'" (Lucas & Beresford, 2010).
- STEM: science, technology, engineering, and math.
- Student success: Achieving academic goals in college.
- Underrepresented minority groups (URMs): Students of color whose self-reported race or ethnicity is African American, Latino, and/or Native Americans/Alaska Natives, and who are not international students (Garces, 2012).

## Organizational Plan

This study used the basic format for a qualitative dissertation with the following organization:

- Chapter 1: Introduction to the Study
- Chapter 2: Review of the Literature
- Chapter 3: Methodology
- Chapter 4: Findings and Results
- Chapter 5: Conclusion

## Summary

Research continues to indicate that underrepresented minority groups lag in the attainment of STEM degrees. This is not a new problem. Census data projects that underrepresented minority groups–especially Hispanics/Latinos–are the fastest growing population in the United States. This study contends that community colleges are a natural pathway to increase minority STEM graduates; the researcher interviewed URMs who completed STEM curricula at a community college to understand and interpret their "lived experience." In understanding why the participants of this study felt they were able to complete a community college STEM degree or certificate, rather than focusing on the individual deficit-oriented approach, this study focused on institutional factors shared through the voices and experiences of URMs who completed STEM academic programs at a community college. It is anticipated that the result of this study will inform and contribute to a body of knowledge intended to strengthen and sustain underrepresented minorities in STEM**.**

# CHAPTER 2
# REVIEW OF THE LITERATURE

*"Scientific innovation offers us a chance to achieve prosperity . . ."*
*President Barack Obama, 2009*

## Introduction

Science, technology, engineering, and math (STEM) careers are important to the positioning of the United States in an increasingly global economy (NGA Center for Best Practices, 2011; Santiago & Soliz, 2012). This fact has been discussed, researched, and known for more than 50 years (Expanding underrepresented minority participation: America's science and technology talent at the crossroads, 2011). A review of the literature supports the statement that the United States is "producing far too few graduates skilled in science, technology, engineering and math" (Bradley, 2011, para. 1). Washington (2011) writes that "STEM barriers are not unique to black people. The United States does not produce as high proportion of white engineers, scientists and mathematicians as it used to. Yet the situation is most acute for African-Americans" (para. 4), Other researchers have come to the same conclusion (Institute for Higher Education Policy, 2012; College Board, 2010; Clewell, et al., 2005; Reyes, 2011; Leggon & Pearson, 2006; Dowd & Malcolm, 2012; Sevo, 2009; Executive Office of the President, 2012). This shortage of STEM workers will have an adverse effect on the U.S. economy (Hagedorn & Purnamasari, 2012). Still, according to Malcolm (2010, abstract),

"The underrepresentation of Latinos (as well as African Americans and Native Americans) in the sciences is not a new problem." The 2011 report *Expanding underrepresented minority participation: America's science and technology talent at the crossroads* states that underrepresented minorities "embody a vastly underused resource and a lost opportunity for meeting our nation's technology needs" (p. 2) and an urgent national call has been issued to address the underrepresentation of minorities in STEM fields (as cited in Dowd & Malcolm, 2012).

Sevo (2009) agrees that "there is a talent crisis in science and engineering that constrains America's economic productivity, competitiveness, quality of life, and security," and identifies several reasons why minority groups are underrepresented in STEM careers: "tradition, discrimination, work/family pressures, inadequate educational preparation, and weak legal or moral pressure to change educational practice" ( p. 3). Reyes (2011) states that conflicts between families and communities add to the problem. A report issued by the Business and Higher Education Forum & Emtect Solutions (2010) confirmed that in order for community colleges to accommodate growth in STEM programs, quality of life issues and the community's beliefs about the value of education must be considered. Research by Dowd and Malcolm (2012) indicates that paid research opportunities at community colleges (and Hispanic Serving Institutions) is critical to increasing URM participation in STEM fields because most of these students need to work while attending college, and the research experience increases the chances of them finding work in STEM fields. Workers who are trained to fill STEM jobs will receive higher pay, experience lower unemployment rates, and have greater opportunities for job promotions and upward mobility (Bensimon & Dowd, 2012).

Salzman and Lowell (2011) argue that many are "overstating and misidentifying" the challenge with science and engineering education and find that there is "no compelling evidence that overall the educational pipeline is failing to meet demand." Despite these assertions, Coleman et al. (2012) write that significant gaps in STEM academic programs exist for URMs, and that "change can be advanced by institutional efforts to develop new institutionally- driven, collaborative relationships tailored to the specific needs of institutions, students, and STEM fields . . . [and] increase the participation in STEM higher education of students of all races, genders, and socioeconomic backgrounds" (p.8). The institutional efforts require leadership that understands the problem, and will effect sustainable change that moves toward solving the problem collaboratively.

A report by scholars Bensimon et al. (2012) discusses the assertion by faculty, staff, and college leadership that the focus on increasing STEM participation should be for "all students," and that programs or policies concerning STEM should "benefit the entire student population" (p. 12). This ideology is one of "color-blindness," which, according to Bensimon et al. (2012) "is not possible in a society and educational system so infused by a history of legal racial discrimination and with contemporary legacies of racism" (p. 12). This ideology will not help increase URM student participation in STEM. To frame the issue, a brief historical background concerning the education of minorities in the United States will be discussed.

## Historical Context of the Study

"*Native Americans have a difficult time with the school system."*

*Native American male participant*

Community colleges enroll more ethnically and racially diverse students than other institutions of higher education (Barber, 2011). In researching, exploring, and examining the education needed for STEM careers, the historical context of the higher education experiences of African Americans, American Indians and Hispanics cannot be ignored, especially male students, where the influence of their racial and ethnic identity (Gardenhire-Crooks, A., Collado, H., Martin, K., & Castro, A., 2010) is an important factor for academic success. Historically, African Americans have been systematically subjected to "legalized discrimination and social oppression" (Evan, 2009; Alexander, 2010). Research by Carroll (1988) and Lang (1992) indicated institutional factors in the success of African American college students are significant. Emerging research supports the concept that institutional factors play a prominent role in the academic success of African American males (Bush & Bush, 2010).

American Indians have been characterized as the "Indian education problem" and as "deficit beings" (Deyhle & Swisher, 2011). Historically, they were discouraged from preserving their culture and heritage while being forced onto reservations (Townsend, 2006). Today, there are more than 560 federally recognized tribes with a diverse population concentrated mostly in Arizona, California, New Mexico, Oklahoma, and Texas. Boyer (2012) writes that math and science were once considered "non-Indian"

disciplines and not a focus of tribal colleges on the reservations where most American Indians received their higher education (p. 18).

Historically, many Hispanics have lacked a significant K-12 education because of the impact of migrant worker status, and were forced to fight the stigma of the undocumented worker while English-only laws emerged in states across the nation (Townsend, 2006; Grow, et al., 2004, p. 70). Even so, the latest census information (2010) identifies Hispanics as the fastest growing ethnic group in the Unites States. Dowd (2012) states that for many Hispanic/Latino college students, community college is the starting point for STEM success (p. 15). Providing the resources needed to help Hispanic/Latino students who come from marginalized public school systems is an important role for community colleges.

Levine (2011) writes that " . . . more than half a century following the Brown [v Board of Education 1954] ruling the U.S. public school system remains potently segregated, with millions of lower-income black and Latino students marginalized in schools with vastly inadequate educational resources . . ." (p. 97). Although URMs represent 40% of the K-12 public school system, they represent only 27% of the associate's degrees and 17% of the bachelor's degrees earned in the United States (Hrabowski, 2012). Statistics indicate that minorities are underrepresented in the science and engineering pipeline at every level from elementary school, through college and into the workforce. Dowd (2012) states that the problem with math and science education in the United States is systemic throughout the entire school continuum (p. 15). The academic preparation of students during their K-12 education affects degree attainment in

STEM fields, and disparities in science and math in URM public school districts result in some students "starting off farther behind" (Coleman et al., 2012).

It has been suggested that aggressive tutoring and mentoring during the K-12 years could help close the URM educational disparities (Griffith, 1998), which is why the public school educational system has been the focus of the majority of STEM education programs. At the same time, community colleges are an important starting point and pathway for many URMs in general and should not be overlooked as an option that can narrow educational disparities by providing academic and social support, and an effective developmental education pathway for students from all types of K-12 educational systems who may consider a STEM career later on in life.

## Developmental Education

> *"Most people come from blue-collar working families or people who think like blue-collar workers. They are taught procedures. Math is concept–procedures go out the window."*
>
> *Hispanic male participant*

The K-12 educational systems in which many underrepresented minority students live have public schools that are in crises (Ivery, 2011). Many are underfunded, with low-performing and underprepared students who will need developmental courses in college (Perin, 2006; Salzman & Lowell, 2011; Boggs, 2011; Levine, 2011). These schools are defined as predominantly minority schools (over 50% of the student body are students of color) and the definition itself may negatively affects academic achievement (Spencer & Reno, 2009). Spencer and Reno's study (2009) indicated that schools with higher populations of students of color had an "adverse affect (sic) on both individual math gain scores from $7^{th}$ - $12^{th}$ grade, and on the number and difficulty of math courses in high

school students completed." Why is this the case? While this is not the specific topic of this study, it is important to note that McCloskey's 1967 research suggested that the poor economic environment/condition of the community in which "disadvantaged youth" live affects students physically, emotionally, and mentally; this influences the teacher's perception that the students are intellectually limited and so they are treated as such. In 2012, there exists this idea that URM communities are pathological, which contributes to the educational and economic disparities in achievement (Ivery, p. 2011).

The research is clear that the educational and economic disparities in achievement of most students who are underprepared for college will result in a need for additional help in math, reading, and writing in order to prepare them for college-level courses (Olson & Labov, 2012). The NGA Center for Best Practice (2011) brief reports that in the 2003-2004 academic year, almost 29% of students in community colleges enrolled in at least one remedial course in their first year; this number increases to 60% over their entire college career. Dowd (2011) reports that in the 2007-2008 academic year, 42% of students enrolled in community colleges took at least one remedial course. The Center for Community College Engagement (CCCSE) (2012) indicates that 72% of respondents to their survey reported that they "took a placement test and needed developmental education in at least one area" (p. 7). Sherwin (2011) writes that about 80% of students enrolled in tribal colleges take at least one developmental course. Community colleges can offer the hope of a college education for students who, as the statistics suggest, may be unprepared and might otherwise not receive one.

Within the current developmental course structure, although most of the students are successful in remedial/developmental reading, less than 50% are successful in their

math classes. Of greater concern is that only one third of the students needing developmental math complete the sequence, and even fewer are successful in passing/completing credit-bearing math classes. These statistics are alarming, specifically when minorities have the highest enrollment in postsecondary developmental education (Attewell et al., 2006). McPhail (2013) has stated that "Among those underrepresented minority students who begin their community college careers in developmental mathematics are the future engineers needed to provide the scientific and engineering skills to solve the problems of energy independence, environmental sustainability, infrastructure replacement, and many other pressing societal needs."

A study conducted by Hagedorn et al. (1999) across 23 colleges and universities in 16 states found that of the students enrolled in remedial mathematics, 57.4% were minorities (African Americans and Hispanics). Other researchers estimate that almost 50% of African American and Hispanic students take remedial math while enrolled in community college (Dowd, 2012). Most recently, renowned community college scholar Dr. Kay McClenney stated that only 17% of students who need developmental math complete the sequence.

The high number of African American and Hispanic students who take developmental/ remedial math in community college is a result of placement tests of which the validity has been questioned. The National Association of Developmental Education (NADE) asserts a holistic view of developmental education, which is defined as "organized efforts to develop the cognitive and affective talents that describe the whole student . . . and describes any and all below college-level courses … (including) all forms of learning assistance, tutoring, mentoring, supplemental instruction,

personal/career counseling and academic advising" (The White Paper Group, 2007). But research shows that most students do not complete the developmental math sequence, and that African American and Hispanic students have low success rates in remedial math courses.

A study by Bahr (2007b) states that - "by definition, [developmental] education is intended to restore opportunity to those who otherwise may be relegated to meager wages, poor working conditions and other consequences of socioeconomic marginalization" (p. 5). There are many proponents of the developmental education concept, but for others, the idea of having developmental math at the college level is simply lowering academic standards and conflicts with the goals of higher education (White Paper Group, 2007). The open door/open access of community colleges aligns with the goals of developmental education, which is important to diversity, equity, and increasing the STEM pipeline for underrepresented minority groups. Bahr (2009) observed that there is a persistent disadvantage in the math achievement of African American and Hispanic students starting in kindergarten, which follows through the 12$^{th}$ grade. With this disadvantage is a startling statistic: By the end of 12th grade, only 25% of Blacks and 20% of Hispanics are prepared for college-level math, compared with 39% of Whites (Bahr, 2010). These students will likely require developmental education courses from their community college.

Chase, Dowd, Pazich, and Bensimon (2012) write about how the ongoing struggle for college access of many *minoritized* (underrepresented minority groups) is highlighted when colleges require mandatory assessment and testing for placement. Chase et al. (2012) further writes that "[w]ith remediation relegated to community colleges,

minoritized students, more so than affluent white students, who have the option of attending private colleges, became caught through testing regimes in the basic skills curriculum . . . Whether basic skills coursework functions as a form of tracking or as an equitable second chance for students who were failed in their primary and secondary schooling depends on whether the necessary resources are provided to ensure that students gain access through these entry points to degree-credit courses" (p. 31).

Moreover, we now find that African Americans, American Indians, and Hispanics are at the center of discussions about the gap for underrepresented minorities in STEM careers. The NGA Center for Best Practices brief states that remedial math in community colleges is ineffective (2011), and is therefore a barrier to many students who would consider a STEM career. This barrier is even more distressing for URMs. The institutionalized academic pedagogies needed for minority students who come from communities where the culture may be much different from a college campus requires a scholarly, yet robust and culturally sensitive approach to developing and framing a strategy to increase and broaden minority participation in STEM. According to Bragg (2012), a survey conducted by the Conference Board of Mathematical Sciences found that only 60% of two-year colleges offer special math programs for minorities, while 90% of two-year colleges require diagnostic testing for placement in math course. Many of the students taking so much developmental math will never reach the college-level math required for STEM careers. Reclaiming The Dream (AACC, 2012, April) describes developmental education as too often being the "burial ground" for the aspirations of many community college students, thereby limiting STEM graduates.

In order to be successful in STEM programs of study, math competency is essential. Math instructors throughout community colleges have noted that college-level math has been "overshadowed" by developmental math (Bragg, 2012). Approximately two thirds of the students enrolled in the community college developmental math sequence do not complete it and the normal college-level math sequence is never attempted (Cullinane & Treisman, 2010). Using data from Ohio, Bettinger (2012) reported that in two-year colleges, only 14% of students who declared a STEM major when entering the community college remained in the field at their last enrollment, and 30% changed to business. The opportunity to attend a community college has been transformational for many first-generation and minority students for whom access has resulted in academic success. However, for those who are unable to navigate the math sequence beyond the developmental level, it may not be possible for them to experience academic success beyond the community college level Ardona & Nora (2009). This is a bottleneck in the STEM pathway for URM that should be addressed.

## STEM and Race

*"Because there are so few of us (in STEM) it's like pushing a rock up a steep hill . . ."*
*African American female*

This researcher posits that strengthening the community college pipeline is the best way to increase minority participation in STEM majors that lead to STEM careers. Other researchers have suggested further studies on the institutional factors that encourage minority students to complete STEM programs (Hubbard & Stage, 2010). The development and synthesis of models that encourage URMs to continue their postsecondary education beyond the community college level is important. The

engagement of the college administration, staff, and faculty is a key institutional factor that can remove barriers. Even more important is an environment where there are significant minority role models present at the institution.

Sevo (2009) writes that the "lack of diversity in the [science] faculty is one of several barriers to new students [entering the field] because it signals that science careers are exclusive and possibly discriminatory." Some minority students report that many faculty at predominantly white institutions are skeptical of their ability to perform college-level work, which affects their performance and enthusiasm, and ultimately results in them leaving STEM majors (Hubbard & Stage, 2010; Olson & Labov, 2012). Research done by Archidiacono, Aucejo and Spenner (2012) indicates that STEM courses are harder and require more study time, which means that students with weak academic backgrounds are less likely to persist in those fields. This is especially troubling in that many URMs who are not academically prepared for college when they graduate from high school will most likely not select or persist in a STEM field.

In 2001, a "Diversity Scorecard" initiative was developed to create change at institutions of higher education to close the achievement gap for underrepresented students, especially those who are not academically prepared. In reference to access and achievement, this initiative encouraged the institution to ask questions such as, "Do particular majors or courses function as 'gatekeepers' for some students and 'gateways' for others? For example, is there a race bias in physics and mathematics?" (Bensimon, 2004). Consideration of a STEM Diversity Scorecard may be necessary in that internal and external influences concerning academic success of students in STEM fields at

community colleges need further examination as they play a role in the STEM educational pathway of minorities and women (Starobin, Laanan & Burger, 2010).

A report issued by the United States Department of Commerce Economic & Statistics Administration (July, 2011) found that there are large disparities in STEM employment across race and ethnic groups in the United States and reported that non-Hispanic Asians with jobs in STEM were at 15% percent, Hispanics were at 2 %, Blacks (African American) were at 3%, and American Indians and Alaska Natives were at 3%, which combined is less than a quarter of the entire workforce with STEM jobs. This report also acknowledges that a boost in minority participation in STEM will increase the United States' talent pool, which will help with global competition. However, in considering the reasons for the low minority participation in STEM, the report states:

> ESA primarily focuses on using data to present the facts and inform discussion of important economic issues. With this disclaimer in mind, there are some possible reasons behind these findings: racial and ethnic stereotypes, a lack of STEM role models, or relatively low resources available for education. Any combination of these and other factors may play a role in lagging STEM employment rates among some groups.

The results of research over the past few years suggest that "segregation–namely racial and class" is an important factor in decreased academic performance in the public school system) that contributes to the academic achievement gaps (Spenser & Reno, 2009. Jaschik (2009) states that college and university programs can do many things to recruit and promote young people in science (Hubbard & Stage, 2010) regardless of race and color, such as having minorities well represented in their student, faculty, and staff (e.g. recruitment) positions and having science curricula and texts that are culturally

diverse and represent all of the theories and scientists (both historically and in contemporary society) that have contributed to science knowledge. In a 2010 report issued by the National Academy of Sciences, the topic concerning the need for "well trained highly qualified teachers of mathematics" is discussed. These and other aspects of the barriers and challenges presented in STEM degree attainment by URMs can be found in critical race theory research.

## Critical Race Theory

Critical race theory (CRT) recognizes the nature of race in the United States educational system and "seeks to promote increased equity and social justice for people of color" (Gildersleeve, Croom, & Vasquez, 2011). Critical race theory is also a challenge to the dominant culture ideology that moves academic inquiry beyond frameworks of individual responsibility and success to discussions around the unexamined institutional and systemic factors that affect success of URMs (Gildersleeve, Croom, & Vasquez, 2011). The development and enhancement of models that encourage underrepresented minorities to pursue STEM careers requires a serious evaluation of the systems in place that support URM groups. This research posits that community colleges offer the best opportunity to increase minority participation in STEM majors that lead to STEM careers. Community colleges are a vital part of the economic stability, growth, and viability of the United States, yet fewer than half of the students who enter community colleges attain an associate's degree or certificate within six years. The numbers are even higher for students of color (Achieving the Dream, 2013). Increasing minority participation in STEM programs at community colleges is a challenge that can be met only with a strong commitment and recognition from leadership within the academy that

STEM curriculums and programs matter. Providing the necessary support and sustaining this support by engaging URMs in STEM curricula can broaden participation in careers that contributes to the economic stability of the United States.

In 1994, the National Science Foundation created the Advanced Technological Education (ATE) program, whose goal is to prepare workers for high-technology careers as well as increase the STEM knowledge of students at all educational levels. Since 1994, ATE has become the largest community college initiative in the NSF portfolio. The October/November 2012 issue of the *Community College Journal* reports that of the students who enrolled in at least one ATE "supported course," 45% were URMs and 52% were enrolled in a two-year community college (p. 22). Ullman (2012) writes that recently, the U.S. Department of Commerce reported that only "one in every eighteen workers" in the United States is employed in a STEM field. Not only does the pipeline need to be strengthened, but sustained. According to Bensimon et al. (2012), improving diversity in STEM has focused on the "demand" side of the issue, and on "fixing presumed student deficits through attempts to improve their aspirations, motivation, or willingness to succeed . . . rather than on fixing the 'supply' side of improving the quality of STEM education." Hispanic and African American students enter college interested in STEM as a career at the same rate as White students; however, somewhere along their educational journey, their numbers are reduced (Sevo, 2009). What is happening within these institutions is an important question. Perhaps the answer lies somewhere in between: Take the students who are motivated and aspire to succeed and improve STEM education by meeting the specific needs of URM students. Systems that leave oppressive power dynamics intact (DeCuir & Dixson, 2004; Davis, 2007), creating barriers to

success for URM students, need to be closely examined in discussions of increasing URMs in STEM.

## Community Engagement and STEM

*"My feeling is that if we, we being the community, not just universities, want to improve the numbers, we can. It is a choice or decision that we have to make."*
*African American male participant*

Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs) have provided decades of educational opportunity and leadership to their respective groups, taking into account the cultural, historical, and social aspects of the students who attend. This important connection with minority groups aligns with Taylor's (2009) definition of community engagement and encourages collaborations and partnerships within the communities in which they are located, just as community colleges purport in their mission statements.

In identifying the traditional minority groups, very little data is available on community engagement of Native Americans and Pacific Islanders; hence, engaging these communities as partners could help increase their enrollment in community colleges. We do know that HBCUs, HSIs, and TCUs respect the cultural richness of the students who attend, and strategies that support the cultural richness of the community college student can help strengthen the pipeline of URMs in STEM careers (Reyes, 2011). The word "community" in community college is intentional and not accidental (Reclaiming the Dream, 2012).

The open door/open access philosophy of community colleges, on the surface, is viewed as an opportunity, especially for men of color, many of whom received messages

while in high school that they were not college material (Gardenhire-Crooks, et al., 2010). Still, community colleges must be prepared to meet the needs of diverse students as the workforce shifts to an economy that focuses on technology as the United States competes globally (Watson, 2009; Hagerdorn & Purnamasari, 2012). Poverty, unemployment, neighborhood decay, urban flight, and low-paying jobs plague many minority communities, and these issues enter the college community with the students. While seeking ways to broaden URM participation in STEM careers, the importance of forming partnerships and collaborations with the underrepresented communities must not be overlooked, but remain in the forefront. These partnerships should include K-12 systems, service clubs, philanthropic organizations, fraternities and sororities, federal grant agencies, and businesses (Holoman, 2010). The engagement of URM communities in increasing URMs in STEM is another important dimension to solving the problem. This is an important aspect to consider for meaningful collaborations with URM communities.

The literature suggests that by exposing minority students to scientific literacy programs, student success will increase, and community colleges can play a vital role in increasing diversity in the STEM pipeline by leveraging access to minorities (NGA Center for Best Practices, 2011). David Bailey (2012), who is working on a definition of scientific literacy for Delta College said that "Scientific literacy describes an individual's knowledge of scientific terms, concepts, relationships, and processes as well as the ability to apply scientific knowledge in a relevant context for personal and social decision making" (personal communication October, 10, 2012). However, there is another variable that may contribute to success in STEM that needs to be explored further–the connection

of exposing students to professional organizations and societies that can motivate and encourage persistence in STEM curriculums. Professional organizations and societies such as the American Indian Science and Engineering Society (AISES), the National Organization for the Professional Advancement of Black Chemists & Chemical Engineers (NOBCChE), the Society for the Advancement of Hispanics/Chicanos & Native Americans in Science (SACNAS), and the National Association of Minorities in Engineering (NAME) all have missions and goals to increase minority representation and interest in STEM careers. Community colleges are in a great position to establish and engage collaborations and partnerships with these affinity groups and everyone at the community college should be involved in making these connections, as the outcomes, quality, and sustainability of the engagement can enhance minority participation in STEM careers. In a true effort to engage the community, everyone at the college should take on leadership roles outside of the college community (Swan, 2009, p. 75) to connect and form partnerships and other opportunities that benefit URM students, the institution, the community, and the United States.

## Community Colleges and STEM

Making a commitment to long-term sustainable programs and initiatives (Blake, 2009) such as STEM requires community partnerships and collaborations–not only in the immediate area served by the local community college, but beyond. This commitment also requires innovation in teaching, learning, and other support services for the identified constituency – URMs. The Chronicle of Higher Education (Oct. 25, 2012) reported that faculty in undergraduate STEM disciplines continue to use lecture as the "most common method of teaching" and that continuing to use this method is "stymieing efforts to

increase the number of graduates in these programs" (Berrett, 2012). This data was secured from a faculty survey in which 63% responded that lecture is the most predominant pedagogical tool used for teaching STEM even though there are other teaching methods that could be used in the classroom.

In 1999, Richard Riley, the U.S. Secretary of Education, appointed a National Commission on Mathematics and Science Teaching for the 21st Century chaired by John Glenn. The charge of the commission was to "investigate and report on the quality of mathematics and science teaching" and to consider ways to improve math and science in the K-12 classrooms (National Commission on Mathematics and Science Teaching for the 21st Century, 2000). The report issued by this commission, *Before It's Too Late,* found that despite how society has evolved, teaching methods in U.S. schools have not changed in the last 50 years and remain predictable:

1. A review of previous material and homework.
2. A problem illustration by the teacher.
3. Drill on low-level procedures that imitate those demonstrated by the teacher.
4. Supervised seatwork by students, often in isolation.
5. Checking of seatwork problems.
6. Assignment of homework.

This teaching method does not address the "why" in math and science, which is not effective, does not encourage student engagement, and is not helpful to many URM students.

Meaningful student engagement in the higher education campus community contributes to success (Tinto, 2012). As community colleges strive for innovation,

inclusion, and success, introducing new pedagogies that enhance student learning and success in STEM programs provides another opportunity to strengthen the pipeline. Researchers have suggested further studies in the institutional factors that encourage minority students to complete STEM programs (Hubbard & Stage, 2010).

## Summary

Underrepresented Minority Groups — African Americans, American Indians and Hispanics — represent an untapped resource that can potentially help the United States meet the STEM workforce demands that are predicted for the future. Some scholars think that the problem is exaggerated, while others think that the U.S. crisis is real. All agree that African Americans, American Indians, and Hispanics are underrepresented in STEM education and careers. In order to increase this representation of minorities in STEM, understanding the historical context and relationships that URM groups have with the educational system in the U.S. is important. In addition, developmental math education has had a disparate effect on URM students moving through the pathway to a STEM education. Critical race theory encourages an examination of systems in place that create barriers to success for URM students. Finally, the mission of community colleges requires a thoughtful engagement of the community and all stakeholders of the college to become involved in solving this problem.

# CHAPTER 3
# METHODOLOGY

*"A theory is an explanation…"*
*— Stephanie Y. Evans, 2009, p. ixi*

## Introduction

This chapter defines the theoretical and philosophical framework of the study. It also discusses the research design and research plan for the study. The reliability, validity, and generalization of the study are discussed, as well as the structure of the research. This chapter provides the details concerning the demographic makeup of the participants, such as ages, ethnicity, job titles, and sex, as well as the interview development and recruitment. The steps and strategies used to address biases, assumptions, and ethical issues are also covered in this chapter.

## Overview of Research Design

Qualitative research is born out of an interest in understanding how people interpret and find meaning in their experiences (Merriam, 2009, p. 5). Qualitative research is ". . . an umbrella term covering an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world" (Merriam, 2009, p. 13). Qualitative research as it is today emerged from the work of two sociologists: Barney Glaser and Anselm Strauss, who made a case for "inductively"

analyzing social phenomena. To inductively analyze is to “build patterns, categories and themes from ‘the bottom up’ by organizing data into more increasingly abstract units of information” (Creswell, 2007, p. 38). Merriam (2009) writes that “Philosophers Edmund Husserl and Alfred Schultz presented phenomenology early in the twentieth century as a major orientation to social science” (p. 9). Patton (2002) explains that ‘by phenomenology Husserl (1913) meant the study of how people describe things and experience them through their senses as we can only know what we experience” (as cited in Merriam, 2009, p. 9).

Because there is not a consistent philosophical perspective in qualitative research, it is up to the research writer to make sense of philosophical influences in his or her own way (Merriam, 2009, p. 8). In qualitative research, the researcher is the primary instrument for data collection and analysis. The data gathered builds on concepts, hypotheses, or theories, and the findings are presented as themes, categories, and concepts that are richly descriptive. The design is emergent and flexible and the sample selection is nonrandom, purposeful, and small, relative to qualitative research (Creswell, 2009).

This particular research is a phenomenological study, whose purpose is to describe a phenomenon–that is, the lived experiences–that are the essence of being an URM STEM (science, technology, engineering, and math) student at a community college. There is little research on this topic as it relates to community colleges, which makes qualitative research the best method to “uncover and interpret" (Merriam, 2009, p. 24) the meaning of the participants' experiences. The method is exploratory, and the voices of the participants are heard through the data collected. The researcher interviewed

community college graduates from three underrepresented minority groups: African American, American Indian, and Hispanic/Latino. The same open-ended questions were asked of all the participants in the study, who were assigned pseudonyms and are identified with their actual ethnicity. Follow-up questions varied based on the researcher clarifying a participant's response, or the participant needing clarification of the question.

There was also a survey administered as part of the study to broaden the understanding of the math experience of URM participants who completed a STEM curriculum. The intent of the survey was to better understand and explain the results of the participant interviews, and it is embedded in a secondary form to support the primary qualitative study.

## Research Questions

The guiding questions for this study are: What are the lived experiences of URM students who completed STEM programs at community colleges? How do these URM graduates describe their STEM experience at a community college?

In support of the guiding questions, the sub-questions of the study are:

1. What themes emerged in the interviews that support the lived experiences?
2. What underlying beliefs came out of the themes based on the interpretation of the themes?

Other questions considered by the researcher are the following:

1. How do the selected URM graduates describe community college collaborations with their communities to strengthen scientific literacy in the U.S. of underrepresented minority groups?
2. How do race and degree attainment intersect with select URM graduate STEM experiences at community colleges?

3. What is the framework for creating a STEM model for underrepresented minorities in the community colleges?

## Research Design

The design chosen for this qualitative study is phenomenological, which "identifies the essence of human experiences about a phenomenon as described by participants" (Creswell, 2009, p. 13). As a philosophy, understanding the lived experience uses a method of studying a small number of participants, from 5 to 25 individuals (Pokinghorne, 1989). Phenomenological research incorporates aspects of a basic qualitative study with the goal of "understanding how people make sense of their experiences," with the added dimension of understanding the structure of the phenomenon (Merriam, 2009, p. 37). Understanding the structure of the phenomenon means approaching the experience in a way "to determine what the experience means to the people who have had the experience" (Moustakes, 1995).

## Theoretical Framework

The theoretical framework for this study is psychological, about which Merriam (2009) writes:

> Concentrates on the personal, including thoughts and motivations, and will emphasize inductive processes, contextualized knowledge, and human intention. This holistic approach includes the cognitive, affective, motivational, and environmental aspects of sense making. (p. 33)

The underlying philosophy and methodological approach of this phenomenological study is hermeneutics, which involves the cultural and social forces that influence the experiences in a way that the meaning is understood (Moustakes,

1994). Exploring the experiences of URMs who completed a STEM academic program at a community college can help frame the role these colleges can play in increasing and strengthening the STEM pipeline. In this research, URMs are defined as African Americans (AA), American Indians (AI), and Hispanics (HS).

## Historical and Contemporary Context of Theories

During the early years of the community college movement, a holistic, or integrative, approach was incorporated in the educational process (Cohen & Brawer, 2008). This researcher posits that the pathway for URM student completion in STEM is embedded in a holistic approach, combining Chickering's (1993) theory of student success and Vincent Tinto's (2012) theory of student retention. The theories of these two scholars go hand in hand: In order for students to be successful, they must be retained in college to complete their goals. In the opinion of this researcher, Chickering's theory focuses on the student and Tinto's theory focuses on how the environment influences behavior through "it's interaction with characteristics of the individual" (Chickering, 1993, p. 3). In his book *Education and Identity* (1993), Chickering describes his theory as psychosocial, which takes into account "a series of developmental tasks or stages, including changes in thinking, feeling, behaving, valuing, and relating to others and to oneself" (p. 2). Tinto (2012) integrates both the social and the academic processes of the individual and the institution. Implicit in Tinto's theory is the idea that students need integration into:

1. Formal (academic performance) and informal (faculty/staff interactions) academic systems; and
2. Formal (extracurricular activities) and informal (peer-group interactions) social systems.

At the 2012 Michigan Community College Association (MCCA) Student Success Summit held in Lansing, Michigan, Tinto stated that "Student success requires intentional, structured, and proactive action that is systematic in nature, and coordinated in application." The "non random, criterion based" (Merriam, 2009) theoretical framework of this research weaves elements of Tinto and Chickering together to consider how the lived experiences of the participants can strengthen and increase the STEM pipeline for URM groups through intentional institutional practices and action.

## Reliability, Validity, and Generalizability

In that the researcher is the primary research instrument of this study, with the collection and analysis of data, ethical dilemmas are a concern (Merriam, 2009, p. 230), as are reliability, validity and generalizability. Creswell (2009) writes that "Qualitative validity means that the researcher checks for accuracy of the findings by employing certain procedures, while qualitative reliability indicates the researcher's approach is consistent across different researchers and different projects" (p. 190). To check for reliability and consistency, the researcher checked for mistakes in transcripts of the interviews. To insure validity, the following strategies, as suggested by Creswell, were used:

- Triangulation of the different data sources to justify the themes found in the research.
- Member check to determine accuracy of themes developed.
- Rich descriptive narratives to convey the results/findings.
- Self-reflection by the researcher.

Seeking meaning by interviewing individuals who have persisted and completed a STEM curriculum at a community college can contribute to the dialogue on increasing and strengthening the URM pipeline. As the primary research instrument for this study, being a licensed professional counselor was an asset when interviewing participants in the study. The ethical conduct of this researcher is balanced with the American Counseling Association Code of Ethics Preamble (2012) and the qualitative research ethical checklist developed by Patton (as cited in Merriam, 2009).

> American Counseling Association Code of Ethics Preamble:
> The American Counseling Association is an educational, scientific, and professional organization whose members work in a variety of settings and serve in multiple capacities. ACA members are dedicated to the enhancement of human development throughout the life span. Association members recognize diversity and embrace a cross- cultural approach in support of the worth, dignity, potential, and uniqueness of people within their social and cultural contexts. Professional values are an important way of living out an ethical commitment. Values inform principles. Inherently held values that guide our behaviors or exceed prescribed behaviors are deeply ingrained in the counselor and developed out of personal dedication, rather than the mandatory requirement of an external organization.

## Ethical Checklist

The interviewing process has risks and benefits for the participants (Creswell, 2009): The participants can share more than they intended to, could feel that their privacy has been invaded, or could be embarrassed by the questions. These are some of the things to consider whether the questions are open-ended, semi-structured, or structured. The Patton "Ethical Issues Checklist" (as cited in Merriam, 2009, p. 233) has 10 items to consider when conducting qualitative research:

1. Examining purpose of the inquiry and method to be used

2. Promises and reciprocity
3. Risk assessments
4. Confidentiality
5. Informed consent
6. Data access and ownership
7. Interviewer mental health
8. Advice (who will be your counselor on ethical matters?)
9. Data collection boundaries
10. Ethical versus legal conduct

In designing the research, it is important to anticipate ethical issues that may arise during the study (Creswell, 2009, p. 87). In collecting and analyzing the data, this researcher was very cognizant of the 10 ethical considerations listed above and adhered to them. In particular, no promises or expectations of reciprocity were made to the participants. Because the number of participants in this study is small, the main focus for protection of participant identity was in the reporting of individual comments within the dissertation. All of the participants are referred to by pseudonym within the dissertation, and the researcher used limited descriptors related to the participants' personal characteristics in order to avoid any possible connection to the individuals. The survey and interview data were kept in a secure location throughout the research study and all paper documents were kept in locked storage in the researcher's home. All electronic data, including audio recordings of the interviews and transcripts of the interviews, were kept in a locked drawer. All electronic files and backup copies of these files were kept on special flash/external drives in a secure location during the research study. Links between

the survey and interview data and the individual participant are contained on one master disk, which also remained in a secure location throughout the study.

The mental health of the interviewer was stable throughout the study. Any questions or advice regarding ethical matters associated with the study were discussed with members of the dissertation committee. There are no legal issues involved with this study from the research proposal stage to the completion of the study.

## Research Structure

The data for the study was collected through a survey, interviews, e-mails, and online documents, which were analyzed inductively to answer the research questions designed to explore the experience of URM graduates of community college STEM curricula. The analysis is presented as a narrative of each participant's story that describes the experience being researched.

In recruiting for the study, the researcher contacted, by phone and/or e-mail, select professional affinity groups and several community colleges and universities that focused on minority STEM programs to inform them of the research. More than 25 e-mails were sent out. Information about the study was provided in the E-mail Recruitment Letter (Appendix B) that was sent to the affinity group contacts and the community college program directors and/or coordinators. The goal of the E-mail Recruitment Letter was to seek help in identifying three to four students from each of the affinity groups and community colleges who met the following criteria:

- A member of one of the following ethnic/racial groups: African American, American Indian, or Hispanic/Latino.
- Graduated from a community college with a degree/focus in a STEM area.
- Is currently working or has worked in a STEM or STEM-related career.

Recruiting contact was made to the following groups and organizations. Table 3 lists the outreach contacts.

- Four professional affinity organizations.
- Four colleges and universities in Michigan.
- One community college in Indiana, two community colleges in Texas, one community college in Georgia, one community college in New York, eight community colleges in California, one community college in Ohio, and one tribal college in New Mexico.

Table 3: Research Outreach Contacts

| NAME OF CONTACT ORGANIZATION | TYPE | CITY, STATE |
|---|---|---|
| American Indian Science and Engineering Society (AISES) | Professional Organization | Albuquerque, NM |
| American Chemical Society | Professional Organization | Washington, DC |
| Community College of San Francisco | Community College | San Francisco, CA |
| Cuyahoga Community College | Community College | Cleveland, OH |
| Delta College | Community College | University Center, MI |
| Dow Chemical Company | Corporation | Midland, MI |
| Dow Corning Corporation | Corporation | Midland, MI |
| El Paso Community College | Community College | El Paso, TX |
| Gavilan College | Community College | Gilroy, CA |
| Georgia Institute of Technology | University | Atlanta, GA |
| Ivy Tech Community College | Community College | Indianapolis, IN |
| Lansing Community College | Community College | Lansing, MI |
| Michigan Technological University | University | Houghton, MI |
| Navajo Technical College | Community College | Crownpoint, NM |
| National Organization of Black Chemists and Chemical Engineers NOBCChE | Professional Organization | Washington, DC |
| National Science Foundation | Federal Agency | Washington, DC |
| Rensselaer Polytechnic Institute | University | Troy, NY |
| San Mateo County Community College District (CA) | Community College | San Mateo, CA |
| Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) | Professional Organization | Santa Cruz, CA |
| Sandia National Laboratories | Corporation | Albuquerque, MN |

| NAME OF CONTACT ORGANIZATION | TYPE | CITY, STATE |
|---|---|---|
| Skyline College | Community College | San Bruno, CA |
| Southwestern College of San Diego | Community College | Chula Vista, CA |
| Stanford University | University | West Palo Alto, CA |
| Solano Community College | Community College | Vallejo, CA |
| University of Texas | University | El Paso, TX |
| Wayne County Community College District | Community College | Detroit, MI |
| West Valley Mission Community College District | Community College | Saratoga, CA |

*Note: Many of the URM STEM programs at colleges and universities focus on K-12 students.*

The next step was to send out Letters of Invitation (Appendix C) to potential participants referred to the study, informing them of the researcher's identity, the purpose of the research, the selection process, and information about the math survey. All participants who agreed to participate in the study were required to sign the Informed Consent (Appendix F) and were asked to take the STEM Math Survey (Appendix H) before the taped interviews, which were transcribed.

A quantitative method was used for the collection of data from the survey. In the research design, the quantitative data was to be collected before the interview in a secondary form to support the qualitative method (Creswell, 2009). This strategy complemented the study and was germane to the research questions: What is the developmental math experience of the URM students who graduated from a community college with a STEM degree or certificate?

This qualitative research followed Creswell's (2007) structure for phenomenological research study and analysis, as indicated below (p. 159):

- Described the researcher's personal experience with the phenomenon. This can be found in Chapter 1 of this research.

- Developed a list of significant statements, which can be found in Chapter 4 of this research.
- Developed the significant statements into themes, found in Chapter 4.
- Wrote what the participants experienced with the phenomenon, in their own words, which is presented in Chapter 4.
- Described how the experience happened, which is found in Chapter 4.
- Wrote a description of the "essence" of the experience as represented in the phenomenon, which is explained in Chapter 4.

## Participant Characteristics

The participants were recruited for the research as a result of:

- Contact made with four affinity groups or
- Contact with select community colleges.

The recruitment process resulted in 11 individuals interested in the study, with eight actually participating in the interviews, the data for which is analyzed. The decision on whom to interview was based on the participants' response to follow-up e-mails or phone calls. The age of the participants ranged from 25 years old to 50 years old. At the time of the interviews, all of the participants were employed full time, seven in STEM fields and one in a STEM-related field. There were three female and five male participants. The females were on average younger than the males, with their ages ranging from 25 years old to 37 years old. The ages of the male participants ranged from 25 years old to 50 years old. In this study, the males were on average older than the females. Table 4 shows the mean and the median age of the participants.

Table 4: Age of study participants

| PARTICIPANT AGE | MEAN | MEDIAN |
|---|---|---|
| All participants | 35.5 | 34 |
| Female participants | 31 | 28 |
| Male participants | 36.8 | 38 |

One criterion for participating in this research was that the participant must either be working or have worked in a STEM or STEM-related field. The ethnicity of the participants included five African-Americans, two Hispanic/Latinos, and one American Indian. Table 5 describes the demographic makeup of the participants.

Table 5: Demographic Makeup of Participants

| NAME | ETHNICITY | JOB TITLE | AGE | SEX |
|---|---|---|---|---|
| Ana | African American | Senior Product Development Chemist | 28 | Female |
| Roa | Hispanic | Lab Technician | 37 | Female |
| Eba | African American | Mechanical Engineer | 28 | Female |
| Lou | African American | Dean, School of Health Science | 50 | Male |
| Pelt | American Indian | Research Assistant | 38 | Male |
| Juan | Hispanic | Community College Math Instructor | 39 | Male |
| Jabar | African American | Marine Engineer | 31 | Male |
| Lee | African American | Customer Service Specialist | 25 | Male |

## Interview Development

Once the individual agreed to participate in the study and was informed of the STEM Math Survey (Appendix H), an interview time was scheduled. Although face-to-face interviews were preferable, phone interviews were also conducted due to the time availability of some and the location of others as indicated below:

- One lives in South Carolina
- One lives in Indiana
- One lives in Illinois
- Five live in Michigan

All interviews are taped with a Sony digital recorder and transcribed professionally. Three of the interviews were face-to-face, and conducted in the following locations: public library conference room, participant's home, and a conference room in

the science department of a four-year university. During the five telephone interviews, the researcher was in the following locations when the interviews were taped: one from a community college conference room and four from the researcher's home office.

There were two sets of questions approved by the Ferris State University Institutional Research Board (IRB), 11 for the initial interview and eight follow-up questions. The first question asked of each participant at the initial interview was "Please describe your community college experience." This was an open-ended question designed to relax the participant, build rapport, and offer the opportunity for participants to begin their story where they were the most comfortable. It was expected that each interview session would last 1–1½ hours.

The first participant interview lasted 40 minutes and focused on the initial interview questions (Attachment F). After the researcher reviewed and analyzed the first interview, it was determined that all of the questions in both sets could be asked in one interview session, and the remaining interview formats were adjusted.

After combining both sets of the interview questions (Attachment F and G), all interviews were approximately 1½ hours in length. At the conclusion of each interview, participants were asked if they would be available for follow-up or more in-depth questions after initial analysis. All participants agreed to answer follow-up questions.

## Procedures

The primary mode of communication with the participants was by e-mail, and all of the individuals who expressed an interest in participating in the research responded to the researcher by e-mail. Upon receiving an affirmative e-mail, the researcher contacted each interested participant by telephone to explain the purpose of the research using the

IRB-approved script (Attachment D). For clarification, during the initial phone conversation, the researcher asked the participants if they met the criteria listed below:

- A member of one of the following ethnic/racial groups: African American, American Indian, or Hispanic/Latino.
- Graduate of a community college with a degree/focus in a STEM area.
- Is currently working or has worked in a STEM or STEM-related career.

There was a two-prong approach to this research methodology:

1. Data were gathered over a four-month period. The research participants were asked to answer 10 questions via Survey Monkey regarding their math educational experience from high school to community college. The questions covered the following areas: math courses taken in high school, math courses taken at the community college, satisfaction of math experience at the community college, and support services provided to help with math at the community college. Demographic information such as ethnicity and highest educational level attained was also asked on the survey.
2. Data was also collected from face-to-face and telephone interviews with each of the participants. The data delved deeper into the participant's community college experience and opinions in the following areas: programs and services, academic and co curricular programs, math experience at the community college, barriers to success faced, STEM curriculum, URM role models, STEM in the minority community, URM advocacy for STEM, and ways to promote STEM programs among minority communities.

## Research Plan

Eight participants were recruited for the research as a result of contact with select community colleges. The participants selected for the study were interviewed about their community college experience in general and their STEM experience in particular. Each one-on-one interview took about 1½ hours to complete. Follow-up for member check and

clarification was done during the analysis of the data collected. The sampling for this research was nonprobability purposeful sampling.

The analysis of the interviews was done simultaneously with the data collection. The system for organizing and managing the data involved following the three steps below:

1. Looking for recurring regularities in the data by breaking the information down into bits of information.
2. The information was then assigned categories, classes, themes, and patterns.
3. Then the data was assigned codes and sorted.

## Summary

This research is a phenomenological qualitative study, with a psychological theoretical framework. The psychological processes, contextualized knowledge, and human intention (Merriam, 2009), the psychosocial developmental tasks or stages (Chickering, 1993), and the formal and informal academic and social systems (Tinto 2012) form a synthesis of the theoretical framework for this study. This theoretical framework is the prism through which the researcher approached the study. The methodology employed other strategies to document the reliability, validity, and generalizability of the study.

There were eight participants in this research, three females and five males, whose ages ranged from 25 years old to 50 years old, all of whom graduated from community colleges in the Midwest.

# CHAPTER 4
# FINDINGS AND RESULTS

## Introduction

The purpose of this study is to examine the lived experiences of underrepresented minority STEM community college graduates who are currently working in a STEM or STEM-related career. This phenomenological study focused on understanding how eight participants who graduated from four different community colleges made sense of their STEM education experience and addressed the following primary research questions:

1. What is the developmental math experience of the URM students who graduated from a community college with a STEM degree or certificate?
2. What are the lived experiences of URM STEM students?
    a. How do URM graduates describe their STEM experience at a community college?
    b. How do URM graduates describe community colleges' collaboration with their communities to strengthen scientific literacy in the U.S. of underrepresented minority groups?
    c. How do race and degree attainment intersect with select URM graduate STEM experiences at community colleges?
3. How do URM STEM students find meaning in completing STEM programs at community colleges?
    a. What themes emerged in the interviews that support the lived experiences?
    b. What underlying beliefs came out of the themes based on the interpretation of the themes?

c. What is the framework for creating a STEM model for underrepresented minorities in the community colleges?

The analysis of the research questions yielded nine themes and seven key findings.

## Organization of the Chapter

This chapter is written primarily in a narrative format and organized around the participants' one-on-one interviews (Appendices F and G) with the participants. Merriam (2009) writes that narratives are considered the "most natural form of sense making" (p.32), which supports the stories of lived experiences as reported in phenomenological research. In this chapter you will hear the voices of the participants through written narratives as they describe their experiences in direct quotes. In order to personalize the data, all quotes are as told to the interviewer and have not been grammatically edited. Charts, tables, and figures of major findings (Merriam, p. 252) are used throughout the chapter to aid in understanding the findings.

The chapter is organized by first presenting a profile of each participant. Then the survey research evidence is presented, followed by a summary of the survey results. Next, the research evidence of the interviews is grouped by themes, enhanced with the participants' underlying beliefs as key findings where those exist. A summary closes out the chapter.

## Participant Profiles

All of the participants in the research are members of one of the defined underrepresented minority (URM) groups: African American, American Indian, or Hispanic. There were male and female participants who ranged in age from 25 years old to 50 years old. The participants are employed in a cross-section of industries: two

worked at a chemical company, two worked at a community college, one worked in a hospital, one worked for a university, one worked with a heavy equipment company, and one worked for a marketing company.

As URM professionals who completed STEM programs at community colleges, the participants were able to navigate pathways for themselves in careers where there are few minorities. The eight URMs demonstrate that a community college education can contribute to the economy locally, regionally, and nationally. All of the participants held underlying beliefs that helped them complete their programs, and the educational access provided by their community colleges helped them to meet their goals. The following profiles will introduce the eight participants with their assigned pseudonyms:

- Ana hated high school, but developed a love of learning at her community college.
- Pelt, a nontraditional older student, gave up his job and moved in with his mother to complete his associate's degree.
- Roa, who is married with one child, did not have a major when she started her community college.
- Jabar, who was raised by his grandmother, initially felt the "social stigma" of attending a community college.
- Lou transferred from a four-year college to a community college because he was not sure of his career path.
- Juan, who attended an alternative high school, did not receive much guidance about college from his college-educated mother.
- Eba became interested in engineering while participating in a high school program called FIRST Robotics.
- Lee prepared himself for college by taking summer math classes at a local community college while still in high school.

The extended profiles on the following pages provide personal snapshots of the participants in this study and illustrate how community colleges can play an important role in preparing URMs for STEM careers.

## Profile 1: Ana

Ana, 28 years old, is a senior product development chemist with a Fortune 500 chemical company located in a small midwestern town. She was born and raised within 25 miles of where she now works. Ana graduated from a predominantly "minority" high school, and she stated that she took advanced math in middle school, but by the time she entered high school she felt that the classes were too diluted. She describes the math at her high school as "core math," which is math that prepares students to work at McDonald's. Ana stated that she hated high school because it was boring to her and was not challenging.

When Ana decided to attend the local community college in her area, she started out not really knowing what field she was going into. Her first thought was that she would consider becoming a veterinarian, but because of allergies, she did not. Ana then thought about studying biology to become an immunologist. However, she credits a chemistry professor with bringing her out of her shell and teaching her how to be assertive. This professor is described as her "major mentor" at the community college that allowed her to really blossom as a student. Ana stated that with chemistry she could use "math, science, and a little bit of biology to apply concepts to learn other things." This experience happened during her first semester at the community college, and it changed her life.

While a student at the community college, Ana was a peer-mentor and really enjoyed helping others. She was involved in the honor society of Phi Delta Kappa, and she spent a lot of time in the tutoring center. She served a year as the president of Phi Delta Kappa and applied for national committees, completed honors courses, and won all kinds of awards. Although Ana was not officially a tutor, often while studying in the library other students would ask her for help. While attending the community college, Ana was employed as a co-op, and used all of her experiences to build her resume. Ana stated that when she transferred from her community college to the university, she was well prepared. In fact, she had been academically prepared so well that she barely attended classes at the four-year university because she felt that she could teach herself the material.

As a working professional, Ana shared that being female and young are major factors in her job more than race. Once people get past that, they notice that she is Black. She did state that in some areas, race can be an issue, and that Black female chemists are so rare that people are curious when they meet someone with those credentials. This annoys Ana, who asks, "Why can't I be educated, why can't I be a chemist, why are people surprised that I am well spoken, like why do I have to speak in slang or have terrible grammar? Why do you assume that I grew up in the suburbs, why do you think I'm lying if I told you I grew up in a pretty disadvantaged neighborhood?" This aggravates Ana.

### Profile 2: Pelt

Pelt, the father of two children ages 18 and 19, is a 38-year-old male of American Indian and Hispanic heritage. His oldest child attends a tribal college. Although he is

biracial, he identifies mostly with his American Indian heritage, which is Chippewa, and he lives on a reservation. He currently works as a research assistant at a large university in a small midwestern town that has one of the largest casinos in the region. Pelt started on his higher education journey as a nontraditional student, has earned associate's and bachelor's degrees, and is working on his master's degree. He plans to continue on to earn a Ph.D. in chemistry.

As a kid about 4 or 5 years old, Pelt stated that he picked up his mom's algebra book — "she tried to go to college but never got through it"— and taught himself algebra. He described himself as being advanced in math from elementary through high school. He took honors calculus in high school, and when he started tribal college, he took trigonometry at another community college because it was not offered at the tribal college.

Before he started attending a tribal college, Pelt did not live on the Indian reservation, but almost an hour away in a medium-sized Midwestern city. He moved onto the reservation to live with his mother so that he could help raise his teenage sister. Prior to moving onto the reservation, Pelt was working and stated that he "was living a kind of iffy lifestyle." Before making the decision to move onto the reservation, he took a class at the tribal college while still working 45 minutes away, liked it, and "made a decision to live with my mom and go to school while I try to help watch my sister." This was a rough transition for Pelt because he went from having money and a job to living with his mom. However, attending college kept him motivated and focused. Once Pelt started attending the tribal college full time, as a descendant and a tribal member, he became eligible for different scholarships, applied for them, and received a "lot of scholarships that were

really helpful." He also worked at the casino, but because he had good grades and all of the different scholarships, he eventually stopped working and became a full time student.

"Are we not real Indians?" This was a question Pelt asked himself and his family while growing up. Attending a tribal college and living on the reservation answered that question and many others, like why he was not raised on the reservation. He also learned the "real story of Native Americans told by people who were Native American." He learned that his family and others left the reservation because there were no jobs there, no money, and that if they had not left the reservation, the "minimum money and food that was here would have to be divided by many more people." Many families were encouraged by the government to move to the cities to "look for promised jobs that they were never given, living in the poorest neighborhoods, attending schools where there were no Indians, and having to fight because you are different."

Academically, attending the tribal college was easy for Pelt, but socially he was an outsider. He took his STEM classes from professors at the local university who taught as adjuncts at the tribal college. They saw his potential, became really interested in him, and mentored him. Pelt became involved in the American Indian Higher Education Consortium and through this applied for a research opportunity with NASA; he was accepted and spent a summer at Cape Canaveral, Florida, at the Kennedy Space Center. He also presented his research at an American Indian Engineering Society conference. This was all part of his educational journey through his association with the tribal college.

## Profile 3: Roa

Roa is a 38-year-old Hispanic female from Mexico who speaks with a thick accent. She lives in a major city in the Midwest and is married with a 1-year-old child. She has a degree in clinical laboratory science and is working full time as a clinical laboratory technician in a hospital. Her responsibilities include analyzing blood or cell samples taken from patients. Roa shared that she had some college experience in her hometown in Mexico, and once she learned to manage the community college experience in the U.S., she liked it. In describing what she liked about her experience, among other things she stated that she "liked the school, the scheduling, and how to pay for her classes." Because she is a hands-on person, the one thing that she liked the most about her experience was working on experiments in the microbiology labs. She describes herself as being a shy person.

Roa felt that it was difficult for her to learn English — Spanish is her native language—and in the beginning there were communication issues with her instructors. However, when she did not understand the instructor, reading the books kept her going. She pointed out that there were instructors who were patient with her and helped her continue on.

Her process of selecting a STEM career started in the community college career center. She was not sure of her major when she started the community college, so she did research on different careers. She did not know that some careers existed, and she needed to decide what to study. Exploring career options was helpful to her.

In thinking back on her community college experience, Roa stated that she was involved in programs that helped minority students and she spoke warmly about her

participation in them. Also, she was a student worker in the minority office at her community college and this offered her the opportunity to interact with a lot of diverse students.

### Profile 4: Jabar

Jabar is a 31-year-old single African American male who has a bachelor's degree in mechanical engineering. Although Jabar was raised in a medium-sized city in the Midwest, he currently works as a marine engineer for a major manufacturing company in the South. He states that he misses his family, but really loves the climate and plans to remain in the South. Jabar was raised by his grandmother after his mother was murdered when he was a toddler. He has one brother who is musically talented, but has not completed college.

When Jabar enrolled in community college, in the beginning he was unsure about it. He shared that he felt a "social stigma" of attending a community college and not a four-year college and of not being able to leave the state to attend college. He was "stuck" on being a mechanical engineer, and his decision to attend a community college was a practical one–his long-term goal was to transfer to a university to earn his bachelor's degree. He is happy that he took the community college route in furthering his education, feeling that he was part of a community.

Jabar describes his community college experience as being very accommodating, hospitable, accessible, and awesome. He was pleased that he was able to be a student, maintain his job, and carve out time in his schedule to study. Jabar was a co-op with a Fortune 500 company in the community. He expressed concern about his awareness of being the only African American in many of his classes in that he came from a

predominantly African American K-12 school system. He feels that underrepresented minority students in college sometimes need "a bit more help in their personal or self-confidence" and that "social counseling or having somebody that looks like them that can relate to their experiences" is important. He stated in a matter-of-fact manner that the community in which he grew up is segregated, and that he does not recall having any Hispanics or American Indian students in his community college classes.

During the summer of his junior year in high school, Jabar took algebra, trigonometry, and some calculus in a summer program. However, when he enrolled in community college, he started with trigonometry based on his entrance test scores.. He did take Calculus I his second semester.

Jabar describes himself as "being his own man." Because of his work and school schedule, there was no time left to become involved in extra- or co curricular activities. A typical community college week for him included two full work days of about 16-20 hours. But he was glad that the individuals he worked for were engineers, which provided a meaningful learning experience.

### Profile 5: Lou

Lou is a 50-year-old African American male. He is the Dean of Health Sciences at a statewide community college system in the Midwest. His educational pathway was not a "normal" path; he has a certificate in respiratory therapy from a community college, worked as a practitioner for a while, started a financial business for a while, and then pursued his baccalaureate and master's degrees in business administration. His goal was to have a career in health administration.

Lou was raised in California during his early years, but his family moved to the Midwest when he entered junior high school. His parents were business owners who groomed him to attend college and in high school he took college preparatory classes. He initially started his education studying engineering at a four-year university, but because he "decided to do something else," he transferred to a community college. He liked math and science and used his time at the community college as a discovery process to determine what he wanted to do. He eventually decided on the respiratory therapy certificate program.

While in community college, Lou attempted to work part time, but realized that he did not do very well working a steady job and attending school; however, he did occasionally pick up work. His parents were a great source of support during his educational journey, and he considers them great role models. He did not utilize the support services offered at the school but rather focused on his studies.

The program that he chose to study in community college did not need much math, but he describes himself as one of those "strange people" who took math anyway, up to precalculus. He appreciated that his program had small classes, was hands-on, and had a theory-to-practice structure. As the current Dean of Health Sciences Programs at the community college he attended, he stated that the structure—at least for respiratory care—is the same as it was when he was a student.

### Profile 6: Juan

Juan is a 39-yearold Hispanic married man with two young children. He graduated from an alternative high school, and has an associate's degree in science and a master's degree in mathematics. He lives in a medium-sized Midwestern city, owns his

home, and teaches math at the community college from which he received his associate's degree. He stated that although his mother attended college, she did not share her experience with him regarding the process needed for navigating college. In fact, when he was young, his mom and dad were not around a lot, and while growing up there was not a lot of structure at home for him, his brother, or his sister. When Juan started his community college journey, he was a computer science major, which required a lot of math classes. He decided after taking so many math classes to change his major to math. When he transferred to a four-year college, he had a 3.91 out of a 4.0 G.P.A. because he received a B+ in Calculus II.

While attending community college, money was a huge issue for him; he had a family to support. He shared that a lot of his friends who started community college with him did not finish because they had so many issues to overcome. He felt that he had to learn to work hard and remain dedicated in order to finish his program. He also did not want his friends to know how hard it was attending college. Juan is a very intense and serious individual.

As a King/Chavez/Parks (KCP) scholar — a program in Illinois, Michigan, and Ohio that encourages students to pursue advanced degrees — Juan has observed that when attending KCP conferences, he "rarely meets any minorities working on technical or STEM degrees."

He definitely utilized the services available at the community college and became close to one of the multicultural advisors there. His relationship with the advisor was a positive aspect of his experience, as was the Hispanic organization that he joined while on campus. His journey was hard work.

## Profile 7: Eba

Eba is a 28-year-old married African American female. She has a bachelor's degree in mechanical engineering and works for a Fortune 500 corporation located in a community neighboring where she grew up. Although she has worked for this company just over two years, she has already gotten one promotion. She describes her community college experience as "feeling like an extension of high school because it wasn't too hard, wasn't too easy, but it was new." To her, the community college was a stepping-stone to attending a university. While at the community college, she gained enough freedom and independence to prepare her for the university.

She also had a co-op job with an automotive parts supplier in her hometown. Her work and class schedule left little time for extracurricular or co curricular involvement at the community college. When she entered college, her first math class was college-level algebra. She took a math class every semester while enrolled in community college.

Eba spent a lot of time on campus studying for her science classes, stating that she studied every day between classes and after classes, often in the library. Her mantra was that practice made perfect, so she would go over her notes again and again to make sure she knew the material. She recalled that many of the young men at the college would try to talk to her when she was in the library, but when they noticed what she was studying (physics, chemistry, etc.), they would lose interest in her.

Eba's interest in science started in high school when she participated in a program called FIRST Robotics. She shared that she originally wanted to be a lawyer, but the FIRST Robotics experience during the 9$^{th}$ through 12$^{th}$ grades in high school changed her

mind. This team was not a school team, but one that a few kids in her school organized on their own. Of the four members on the robotics team, upon graduation from high school, three went directly to a four-year college and one (Eba) enrolled in a community college. The last she knew, two of them did not graduate from the four-year college, and one later enrolled in the community college she was attending. Eba feels that she made a good decision to attend community college first.

### Profile 8: Lee

Lee is a 25-year-old single African American male who has a bachelor's degree in computer science. He is currently working with a large local company as a customer service representative, a job that sometimes requires him to work with computer programs to collect and analyze data. Lee attended community college in his community, attended a four-year university approximately 45 miles from his hometown, and the company he works for is located in his hometown. His mother was quite protective of him and was glad that he attended a four-year college a short driving distance from his home. He is a very polite young man, who showed a great deal of enthusiasm to participate in the research project.

He is the first person in his family to attend college, and he did not have anyone to help him navigate the process. In order to prepare himself for college, Lee took a summer math class at a local community college while still in high school. He actually took trigonometry twice through this program.

Lee had a work-study job while at community college, working in the multicultural office. Because he worked in the multicultural office, he was also involved in a club and had the opportunity to meet many students and work on projects that

brought him in contact with faculty, staff, and students from diverse backgrounds. While at his community college, he felt that he bonded with other students who were enrolled in the same program. By attending a community college, he feels that his exposure to a college environment prepared him for his experience at the four-year university. What he remembers most about his community college experience is the small class size, which allowed everyone to know each other and to help each other when someone was struggling.

## Profile Summary

The educational attainment of the participants is impressive in that in addition to having an associate's degree, all have bachelor's degrees, three earned master's degrees, and one holds a doctorate degree. The profiles are a synthesis of the information gathered in the one-on-one interviews and from the survey.

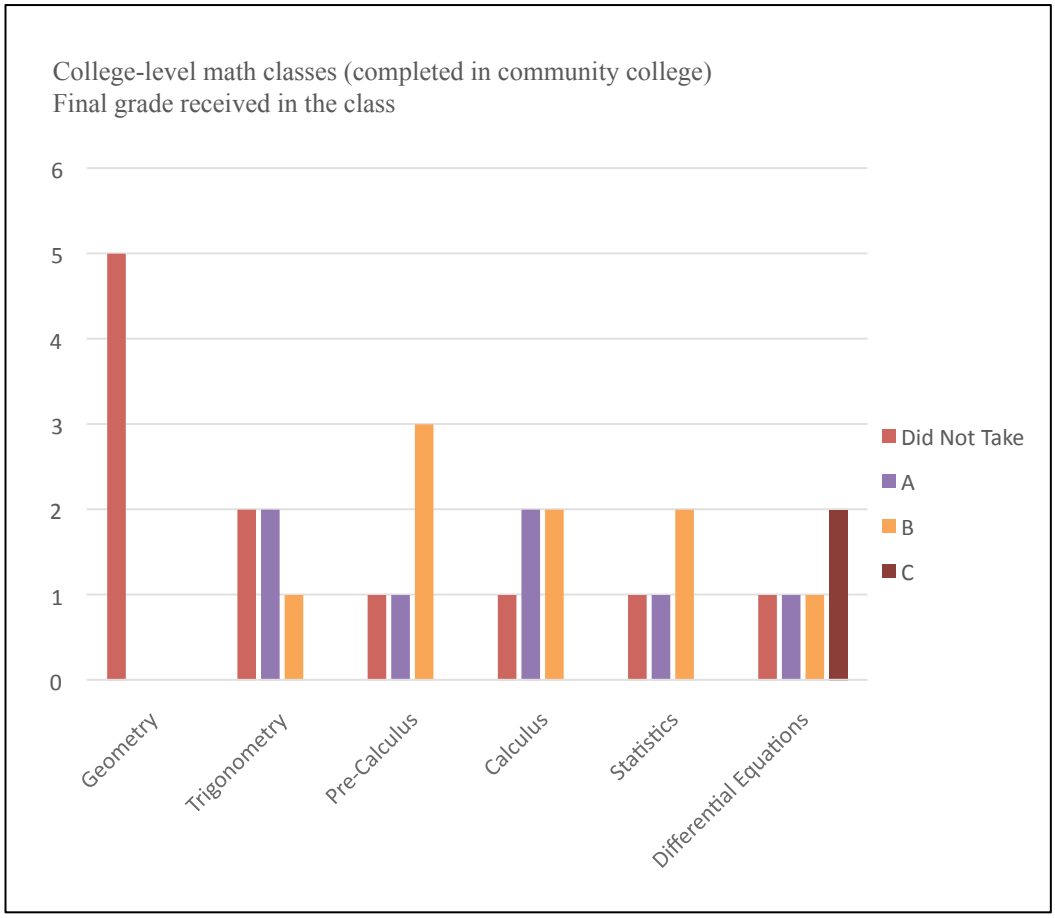
## Research Evidence – The Survey

The survey (Appendix H) was designed to get specific background information from the participants and to gather information to answer the following research question: What is the developmental math experience of the URM students who graduated from a community college with a STEM degree or certificate? Specifically, the survey was designed to gather information on the math experiences of URM STEM graduates from high school to the community college. The initial design was for a larger number of participants; however, information from the survey used in this research was drawn from the eight participants who agreed to be interviewed. Five of the eight participants completed the survey. All of the survey participants had math courses in high school and

in college. None of the participants enrolled in developmental math at the community college.

One question on the survey asked: At what level did you begin your developmental math sequence, and what grade did you receive? The answer choices were: Basic math, pre-algebra, or algebra. All five participants who took the math survey skipped this question. When asked to rate their overall level of satisfaction with the developmental instruction on a scale of 1-10, with 1 being dissatisfied and 10 being very satisfied, all five of the participants skipped this question. In describing their math experience in community college, all of the participants stated that they liked math. The community college experience of the participants is that all enrolled in and completed more than one math course in college, none of which were developmental math courses. Table 6 indicates the community college math courses taken and the grades received of the participants who completed the survey. An analysis of the STEM Math Survey indicated that none of the participants in this study enrolled in developmental courses at their community college.

Table 6: Participants' Community College Math Classes




Another survey question asked about the types of support services the participants received at the community college and asked them to identify the services they participated in as well as indicate how likely the services contributed to their completion of math at the community college. There were seven choices: tutoring, study groups, special topic workshops, math seminars, peer tutoring, instructor office hours, and mentoring. Although the survey response was small, the responses to the questions were revealing. Of the seven choices, none of the participants who took the survey selected

special topic workshops or math seminars as services that contributed to their completion of math at the community college. Table 7 is a summary of the responses.

Table 7: Review of STEM Survey, effect of several factors on Completion of Math Courses

| CONTRIBUTING FACTOR | # OF RESPONDENTS | EFFECT ON COMPLETING MATH AT THE COMMUNITY COLLEGE |
|---|---|---|
| Tutoring | 2 | Definitely contributed |
| | 2 | Likely contributed |
| Study groups | 1 | Likely contributed |
| | 1 | Unsure about contribution |
| Peer tutoring | 1 | Likely contributed |
| | 1 | Unsure about contribution* |
| Instructor office hours | 2 | Definitely contributed |
| Mentoring | 1 | Definitely contributed |

**only 4 respondents answered this question*

## Summary of Survey Results

The intent of the phenomenological study is to find meaning in the lived experiences of URMs who completed a STEM curriculum at a community college. The purpose of the survey was to gather information that added meaning to the participant's experiences, to be analyzed as the themes emerged in the phenomenon that is described (Creswell, 2007, p. 58). The basic assumption of this researcher when developing the survey was that many of the URM graduates from community college STEM curricula would have enrolled in and completed at least one developmental math course. This was not the case for the participants in this study, who were good in math, liked math, and had a strong math foundation upon entering the community college. Hence, their ways of thinking about their community college math experience were that it was challenging, yet positive.

Based on the survey, what is the answer to the research question: What is the developmental math experience of the URM students who graduated from a community college with a STEM degree or certificate? The survey revealed that none of the participants in this study enrolled in a developmental math course, and they completed a STEM curriculum without having to navigate the developmental math pathway. This researcher concludes that the participants in this study completed their STEM program because of having a solid background in math when they started the community college. Developmental math was not a factor for them completing a STEM curriculum.

The participants in this study are a very educated group: Of the five who took the survey, 40% (2) have an Associate Degree in Science, 60% (3) have an Associate Degree in Applied Science, 80% (4) have a Bachelor's degree, 20% (1) has a Master's Degree and 20% (1) has a Doctorate Degree.

## Research Evidence – The Interviews

What are the lived experiences of community college URM STEM graduates? Within the framework of the interviews conducted are the conscious experiences — the essence of the experiences — which the participants have in common. The conscious experiences that the URM participants in this study have in common are that:

- Each enrolled in a STEM curriculum at his or her community college.
- Each transferred to a four-year university and completed a STEM curriculum there.
- Each is a member of a URM group.
- At the time of the interviews, all of the participants were employed in full-time positions.
- Each attended a community college in his or her community.

In reference to the participants attending the community college in their community, all but two attended the community college that served the community in which they grew up; the other two moved into a community with family ties. This indicates that the participants felt a sense of community for the college - some feeling that the community college was not college at all. Within these conscious experiences are the lived experiences of the participants. As a starting point in describing their community college experience, personal reflections of the participants included statements such as:

> My community college experience felt like an extension of high school because it wasn't too hard, it wasn't too easy, but it was new. That is where I took most of my science and math classes that were transferred to the university. —Eba

At the opposite spectrum, one participant stated that he attended community college as a prerequisite for transferring to a university:

> In the beginning I was very unsure of what I would do after, I guess. I was thinking more about long term, I wanted to be at a university, but the actual experience after getting involved and basically getting through the first semester was very accommodating. —Jabar

All of the participants were open to sharing their community college experience. Within these conscious experiences are the lived experiences of the participants and from these conversations; significant statements came together as themes that were formulated from phrases or sentences that spoke directly to the lived experience. There were 117 statements identified from the transcripts of the interviews, which were divided into clusters that gave meaning to the themes established. The established themes are based on

the researcher's interpretation of the meanings from the significant statements. Table 8 contains selected examples of significant statements of the lived experiences of participants in the study, the researcher's formulated meaning, and which themes emerged.

Table 8: Selected Statements with Formulated Meanings and Themes*

| SIGNIFICANT STATEMENT | RESEARCHER'S FORMULATED MEANING | THEMES |
|---|---|---|
| I had the drive but (also) passionate teachers and professors who love what they do. It helps you want to continue when the instructors actually care about how you are doing and they want to see you succeed. | URMs respond well to the encouragement of instructors—feeling welcomed in the environment. | Instructors are important |
| I was the first person to go to college, so there was no one there to say this is how you . . . get information . . . no one was there from my family to say this is how you do this for that kind of major. | First-generation students are on their own when it comes to navigating college, which makes support systems at the community college important and critical. | Tutoring as a support system |
| Overwhelming. Was not what I was used to. It was scary in a lot of ways. Did not know what I was getting into. It was confusing in a lot of ways. | Most of the participants in this study did not have strong guidance on attending college. There was a sense of frustration, insecurity, and fear, and students can feel lost and unsure of what to do. | Motivation/Belief in self is strong |
| My feeling is that if we, we being the community, not just universities, want to improve the numbers, we can. It is a choice or decision that we have to make. | The ability to increase the number of underrepresented minorities in STEM is within the power of colleges/universities and the communities in which these institutions are located. Colleges are choosing not to address this issue, and communities are not responding to the need. | Community engagement is not strong |
| Most people come from blue-collar, working families or people who think like blue-collar workers. They are taught procedures. Math is a concept; procedures go out the window. | In order to grasp math, there needs to be a mental shift in way students think, and an educational shift in how math is taught. To learn math one must be able to think outside the box when solving problems. Innovation is important and people need the freedom to be creative as they learn. | Instructors |

| SIGNIFICANT STATEMENT | RESEARCHER'S FORMULATED MEANING | THEMES |
|---|---|---|
| "Because there are so few of us (in STEM) it's like pushing a rock up a steep hill . . . " | Increasing the numbers of URMs is going to be a challenge and it will be tough to get them into STEM areas. It will take a team effort to have enough strength and patience to make change and a difference. There are barriers that make this a difficult problem to solve. | Race |

*Adopted from Creswell (2007) *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, p. 271

Table 9 provides two examples of how clusters provided the evidence for meanings that support the themes.

Table 9: Examples of Two Theme Clusters with Their Associated Formulated Meanings*

| EVIDENCE | ASSOCIATED FORMULATED MEANING | THEME |
|---|---|---|
| • Teachers wanted you to succeed<br>• Teachers were great<br>• Instructors were caring<br>• Instructors saw my potential<br>• Helped me<br>• Willing to help me | Made a difference | Instructors |
| • Tutoring tables were helpful<br>• Getting help in the Teaching & Learning Center (with tutors)<br>• Tutoring, when I had some trouble in my classes<br>• I didn't go home until my homework was done . . . I sat in the tutor lab | Was important to my success | Tutoring |

*Adopted from Creswell (2007). Q*ualitative Inquiry and Research Design: Choosing Among Five Approaches*, p. 272

During interviews, the verbal responses of the participants were positive, most having intonations that were passionate and lively, with the exception of one participant, Eba, who was reserved. In this face-to-face interview, her affect was serious, and throughout most of the interview she sat with her arms crossed, held close to her chest.

Table 10 includes examples of words used by the participants to describe their community college experiences, divided into positive, negative, and neutral comments.

Table 10: Describe Your Community College Experience

| POSITIVE COMMENTS | NEGATIVE COMMENTS | NEUTRAL COMMENTS |
|---|---|---|
| • Changed life<br>• Gave me direction<br>• Great experience<br>• Feel comfortable<br>• Accommodating<br>• Got me to liking school again<br>• Kept me motivated<br>• Kept me focused on school<br>• Felt part of a community<br>• Happy to take this route<br>• Teachers wanted me to succeed<br>• Different opportunities available<br>• Hospitable<br>• Awesome<br>• Liked it<br>• Pretty good | • Extension of high school<br>• Overwhelming<br>• Scary<br>• Confusing<br>• Stressful<br>• Beginning unsure<br>• Challenging<br>• Difficult | • Spent a lot of time studying<br>• Not too hard, not too easy<br>• Small class sizes (2) |

Comments made by the participants in this research suggest that they were intellectually invested in their STEM program of study. Words such as "hard work" and institutional services such as tutoring were important elements of their community college experience. Table 11 describes what the participants felt worked well as they progressed toward their STEM program.

Table 11: What worked well for your educational journey?

| INTERNAL FACTORS (SELF) | FORMAL INSTITUTIONAL FACTORS | INFORMAL INSTITUTIONAL FACTORS |
|---|---|---|
| • Persistence<br>• Did not go home until work was done<br>• Liked math and science courses<br>• Scheduled classes to maintain job and be a student and study | • Tutoring<br>• Counseling center<br>• Multicultural center helped with paperwork<br>• Curriculum list for various universities that you might want to transfer to<br>• Learning center | • Got to know personal history from the tribal college<br>• Passionate teachers and professors who love what they do<br>• Instructors who actually care about you |

| INTERNAL FACTORS (SELF) | FORMAL INSTITUTIONAL FACTORS | INFORMAL INSTITUTIONAL FACTORS |
|---|---|---|
| • Really good experience<br>• I had the drive<br>• Studying every day | • Career center helped me<br>• Working in the lab in my chemistry courses | • Instructors who want to see you succeed<br>• Being nudged along<br>• Instructors helped me find my own way |

Many community college graduates overcame barriers and challenges while enrolled in college, and the participants in this study were not immune to the challenges faced while being a college student. For example, research by Clewell, Anderson, and Thorpe (1992) identified four major barriers faced by URMs and women entering STEM fields: negative attitudes and perceptions from external sources, poor academic achievement and performance, insufficient course and extracurricular activities, and limited knowledge of mathematics and science professions. Although all of the participants in this study liked math and did well in the subject, in the interviews they also identified *limited knowledge of mathematics and science professions* as a barrier for most URMs of all ages, a finding also by Clewell et al. (1992).

While three of the participants stated that they did not face any personal barriers while attending community college, Table 13 is a compilation of personal, family, and external barriers the other five participants indicated they faced while attending college.

Table 12: What would you say were barriers for you?

| PERSONAL BARRIERS | FAMILY BARRIERS | EXTERNAL BARRIERS |
|---|---|---|
| • None—stepping stone<br>• None—just enough independence to get feet wet<br>• None that I was consciously aware of<br>• My language barrier problems<br>• Wanting to have money | • First person in family to go to college<br>• No one was there from my family to say this is how you do this for that kind of major | • Working was a barrier to studying—assimilating information or retaining it<br>• Stigma of people not knowing me, I was an outsider (tribal college)<br>• Transportation<br>• Awareness that throughout program there were only |

| PERSONAL BARRIERS | FAMILY BARRIERS | EXTERNAL BARRIERS |
|---|---|---|
| • Money<br>• Making enough money to survive | | • 1-3 Black students in math and science classes |

Academically, the participants are an exceptional group. Non STEM-related extracurricular activities did not play a huge role in their experience as demonstrated in Table 13. Specifically, the male participants were quite focused on their academics.

Table 13: Examples of Programs & Services Participation

| CLUBS/ORGS —MALES | CLUBS/ORGS — FEMALES |
|---|---|
| • Don't recall<br>• Wasn't really involved in organizations<br>• Was my own man | • Honors program<br>• Phi Theta Kappa<br>• Peer mentor<br>• Leadership experience |
| STEM-RELATED ACTIVITIES – MALES (M) AND FEMALES (F) | OTHER PARTICIPATION BOTH MALES AND FEMALES |
| • American Indian Higher Education Consortium (M)<br>• Science club (F)<br>• Opportunity to go to NASA (M)<br>• Present research at AIES conference (M) | • Teaching/ learning center<br>• Learning center<br>• Co-op<br>• Tutoring |

## Themes and Key Findings

Themes were developed from the analysis of the information gathered from the interview transcripts and the survey. The narrative that follows includes direct quotes from the participants that support the identified themes and key findings. There are nine themes and seven key findings. The themes are: Instructors, Co-op/Money, Motivation/Belief in Self, Community Engagement, Race, Giving Back to Others, Tutoring, Peer Mentoring, and Small Class Sizes. The seven key findings are the underlying beliefs of the participants based on the themes that emerged.

## Theme 1: Instructors

In this theme the participants focused on the experiences they had with their instructors and the relationships that were formed. In general, when talking about their instructors, participants used words such as "caring," "great," "passionate," "motivated," "good," and "helpful." The words "help" or "helpful" were the most used words when the participants talked about the instructors in their STEM program

In describing the essence of the experience at the community college, and the role an instructor played in helping to navigate the journey, one participant's interaction with an instructor was life-changing as described below:

> I kind of went in (the community college) without any kind of direction or anything. I was very introverted and not very expressive. One of my instructors maybe saw potential in me—I would kind of whisper answers and he would just intentionally ignore me. One day I got fed up so after class I asked him, "Why do you do that? I give you the answer but you clearly just kind of go over it like you didn't hear me, but I know you did because I see you side glance me." He told me he wants me to be more assertive and say it with conviction and confidence. From that point, I was like, okay, he wants me to be like that, and I will do that if it takes that kind of conviction to have him pay attention to me. (My) experience . . . gave me direction. It was a great experience. – Ana

Later in the interview this same participant further expressed her experience with her instructors in a more reflective way:

> I had the drive, but passionate teachers and professors who love what they do (help). It helps you want to continue when the instructors actually care about how you are doing and they want to see you succeed. It kind of gives you motivation, especially the days where you feel like you cannot get this concept. There is no way you are going to get it, but you have those professors who are passionate and

> they actually care about their students so they want to help them any kind of way they can to make sure they succeed. Not really hold their hand but just kind of nudge them along and give them little droplets of information to help them learn to find their own way but at the same time, not totally let them loose. – Ana

Another person commented that he had:

> … great teachers for the most part, willing to help, office hours were very accommodating. – Jabar

A very interesting data point about instructors is that as a group, the participants had from 0-4 URM instructors throughout their STEM curriculum. Table 14 provides a visual of the courses these instructors taught and the number of times the participants mentioned that an URM taught the course:

Table 14: URM STEM Instructors of Participants

| COURSE | NUMBER OF TIMES MENTIONED |
|---|---|
| Math | 4 |
| Physics | 3 |

The lack of diversity in the STEM faculty at community colleges can create barriers to students entering into the field (Sevo, 2009). While the participants in this study did note the lack of diversity in their STEM instructors, their experiences were positive, as indicated by one participant:

> There were some instructors that were patient even though my English was not really good at that time. They will help you. I have some good instructors in community college . . . – Roa

Another participant had a different type of experience at the tribal college in which an adjunct chemistry instructor helped the student by telling other instructors about him:

> Intellectually I think I am far advanced school wise so I had no problem with the education. I took her (chemistry) course and I got really good grades and everything and she really seen potential in me. – Pelt

Having instructors who were supportive, accessible, caring, and passionate about what they do was a huge benefit to the participants in this study. Chickering and Reisser (1993) write that faculty members who "speak with passion challenge the cognitive skills of their students" (p. 318). This is especially true for URMs. This cognitive aspect supports the theoretical framework of the study in that the experiences of the participants allowed them to do well academically in the community college environment, where the instructors let it be known that they were interested in them and were open to building and sustaining relationships with them. This theme led to a key finding:

> **Key Finding 1: The participants in this study believed that having minorities well represented in the student body, faculty, and staff in community college STEM disciplines can help promote STEM careers to URMs.** This is significant in that all of the participants shared that their community college experience lacked racial diversity in the faculty STEM ranks, and they stated that being represented in a positive way is still important for the overall identity, self-esteem, and encouragement of URMs entering into the field. Although the participants were successful in completing STEM programs without significant URM role models in the discipline, this is not unusual. The number of URM faculty in STEM disciplines is low, as are the URM graduates who complete these programs. This statistic has not changed significantly in more than 30 years.

## Theme 2: Co-op and Money

According to Dowd and Malcolm (2012), paid research opportunities are "critical" to increasing URM representation in STEM fields. In this theme, one participant described the experience of working in a co-op job that was aligned with his STEM curriculum:

> I was also in co-op . . . it has definitely made a difference . . . I worked for (company) for about two years as a co-op. – Jabar

Other participants described working at other jobs. The motivation for working was to have money and the ability to support families and self. One participant stated:

> I had a co-op job. I co-oped at [company), an automotive parts supplier. I did that and went to school. The co-op was through my community college. – Eba

The experience of the participant who attended the tribal college was different from other participants in a few ways. He started his college journey as a part-time student and worked part time, but then attended full time while working part time. He stated:

> When I started going full time, I was eligible for different scholarships so I applied for them and I got a lot of scholarships and they were really helpful. I also started working at the casino at that time. The scholarships while working at the tribe, being a descendant, and a tribal member, all of these different scholarships I started to become eligible for and I had really good grades. It really motivated me to keep getting good grades and to be full time and apply for more scholarships. . . More scholarships helped me get on my feet and eventually I didn't have to work. – Pelt

From a different perspective, one participant stated that his desire to have money while attending community college was a barrier to focusing on his studies:

> My only barrier that I recall is that as a young person, I wanted to have money, so I made futile attempts on occasion to find a part-time job. Sometimes that worked out well for me and other times it was a barrier to studying. It was a barrier assimilating information or at least retaining it. I actually, and I only did it for a very short time, I had a position working at night and I would go to school the next day and I found after about three days that that wasn't such a good idea. I kind of backed off from that and again having the support of a good home structure, I was afforded the opportunity to kind of pick up work as I could, but really to focus on my studies. – Lou

Research indicates that most community college students work while in college. This is true of the experiences of seven of the eight participants in this study who worked while students at the community college. One participant's assessment was that:

> Most people could not go to college because of their income. A lot of times they are not successful due to their lack of ability to manage funds and life. Money, of course, is needed. If you are in school you can't work, or if you work, you can't work like you need to make enough money for you to survive. – Juan

The literature discusses that more paid internships and co-op opportunities STEM programs at the community college level is an important strategy in attracting URMs to the field. This underlying belief requires a paradigm shift for community colleges connected with another key finding:

> **Key Finding 2: There is a strong need to provide meaningful work experiences to URM STEM students while they attend community college.** All but one of the participants in this study worked and all stated that having enough money to survive was critical while attending community college. American Indians are the second most likely racial group (after non-Hispanic Black students) to have dependent children while enrolled in higher education and

having a way to financially support a family is critical. The participants in this study had a strong resolve to succeed. One male participant stated that he did not want his friends to know that he was struggling financially because they were not in college and "we were all the same way" -- Jabar.

The implication of this statement is that by being in college, you are somehow different, without the struggle of those who are not attending college. But the financial reality for many URMs in community college is that they struggle. A shift in this reality is needed to make community college STEM programs a more practical pathway and option early in the process for URMs. By increasing internship opportunities in STEM fields for URMs, community colleges may be able to improve the number of URMs who enroll in and complete a STEM degree.

### Theme 3: Motivation/Belief in Self

Another theme that emerged from the experience of the participants was motivation/belief in self. In analyzing the lived experience of the participants, this researcher saw that they believed in themselves and were able to complete their programs, thereby meeting their educational goals. In STEM-related interests and choices, motivation does matter (Wang, 2013). One participant stated:

> I guess just being persistent and when you want something, you will get it because you just have to keep trying at it – Eba.

Another participant described how he accepted the challenge of enrolling in a science course:

> That is really why I wanted to go into STEM because it is like, you know what, I know I can do it. I feel if you have the ability to do something, it is your

> responsibility to do it. That is one of the reasons why I chose to take it. Everybody has hated chemistry so I said I will attack this thing. It was easy – Pelt.

Another participant stated:

> A lot of people started when I started, but a lot did not finish. I had the motivation and desire to complete – Juan.

A participant commented on being focused:

> I think I was lucky that I got really into the career center and I did research on all different careers and I was really focused about that – Roa.

One participant described handling a tough issue in class, one he felt other students may have had difficulty with:

> For example, when I was at (community college), there were some issues that came up for me personally that I didn't like about one of my instructors, but I didn't talk to anybody really at school about it. It was just something that I dealt with personally. Being the person I am, I think that I handled the situation relatively well. I think that some other people probably would have dropped the class – Jabar.

Another participant shared:

> No matter what your skill level is, you can improve to the next level, if you have the drive to do it – Lee.

In contextualizing the participants' motivation/belief in self theme, the researcher noted that engagement was intentional, limited, and linked to key finding number 3:

**Key Finding 3: Being engaged in campus activities such as clubs and organizations is not a factor for community college STEM students completing their program.** *This is a surprise finding.* Student development theories posit that student engagement is important to retention and completion rates**.** However, clubs and organizations were not important for the majority of the STEM-focused community college participants in this study, who were self-motivated and focused.

## Theme 4: Community Engagement

When reflecting on engaging the URM community in preparing students for STEM careers, the participants had quite a bit to say:

> I think the community is aware. I think the community has learned, at least my community I grew up in, to respect people who are educated; (I) think everybody would like, at least in the back of their mind, to have the feeling of completing a degree or program. I think some people may think that it is for someone else. For example, yes, I know education is good. Yes, I may desire internally to get a degree, but everything that they believe at that point in time is kind of telling them they don't think they can make it. I think African Americans, Native Americans, and Hispanics have a great respect for education, just by and large. For the basic human fundamental level, we appreciate education. When we look at the representatives that we have for those doctors, lawyers, engineers, etc., they may not look like them. There is a phenomenon that goes on in the African American community of the educated, that they disappear, and I could be one of those people, for example, that I am actually talking about, that we disappear into the corporate world. To your question, I think that the community is aware that education does provide an avenue to better themselves but sometimes we are just not aware of what that avenue is and how to navigate it – Jabar.

Another participant commented that:

> In my experience, there is a false pretense of knowing that to be true. In reality, they (URM community) are not promoting that. They say they agree with it but they are not promoting it. They are doing like, here is a band-aid. You know, let's throw a couple dollars in it, let's say this and that, but they are not really doing it because if you wanted to do something, you would get a better tribal college. You would invest some money into that and they are not. Do they know that it is for the best of their community? I think some people do, but the majority of the people that are running the show are the same people that would have a difficult time if they were at the tribal college – Pelt.

In that there are so few URMs in STEM fields, the participants felt that it will be hard, if not impossible, to improve the numbers. Along with this perspective is the idea that some communities are in denial about the importance of STEM and therefore, only minimal effort is being invested to increase literacy, as voiced by one participant:

> In my opinion, they say it (STEM) is a priority, but it is not – Pelt.

All of the participants described themselves as advocates for STEM, leading to the underlying belief of linking STEM careers with community growth:

> **Key Finding 4: The URM participants in this study felt that as a whole, minority communities understand the value of a college education, but they are not engaged in efforts to encourage STEM careers.** This is connected to the lack of visible URM role models in STEM disciplines, and the lack of sustainable programs created to increase URMs interest in STEM programs and careers. Most URMs have a limited knowledge of all the different careers to choose from; one participant who chose a STEM career after doing research in a

community college career center stated, “I didn’t know some careers existed. . . . I was not aware of them . . . otherwise, I may have chosen something that would be popular . . .” – Roa. Implied in her statement is that as a high school graduate entering a community college, she had not made a career choice and she started her college career as an “undecided student,” a category many entering community college fall into.

### Theme 5: Race

In talking about race and STEM, all of the participants stressed the importance of having someone that looks like them teach in STEM disciplines and for those who have “made it” to give back to URMs by sharing their stories and experiences. Statements used by the participants to describe the URM representation in STEM were: So underrepresented, still work to do, really low, it could be better, it is awful-terrible, not many women, and there could be more minorities. Most of the participants in this study stated that some progress had been made in the representation of URMs in STEM programs and careers, but that there is still a long way to go. One participant discussed the fact that “because there is segregation in communities, you basically continue to have segregation in the academic world” – Jabar. Another participant shared that “We are not seeing a reflection in terms of percentages of minorities in STEM-related programs and fields that correlates or is equivalent to the population of that given geographic area” – Lou. This is a real issue and concern in moving forward to increase URMs in STEM.

There was another dimension of race and STEM discussed by one of the participants, who thought that other factors played a more critical role for her at this time. She stated in the face-to-face interview that “Female, youth, and gender are major factors

in certain areas, and then after they get past that, then it is, oh, and she is Black kind of thing" – Ana. What was most striking about her comments was that she also stated:

> Being a Black female chemist gives me power in a certain sense . . . . I only take advantage of it when it is absolutely necessary – Ana.

The researcher observed that when discussing this topic, Ana became uncomfortable, as indicated in her tone and body language. During the interview, it was clear that it is easier for her to focus on being female and young than on being an African American in a STEM discipline. Race is the complicated and complex theme in which the underlying belief formed key finding number 5:

> **Key Finding 5: The participants in this study felt that improving the number of URMs in STEM will take a long time.** An estimated timeline was not discussed, but the acknowledgment that increasing the number of URM students in STEM will be challenging is an important part of the conversation. One participant stated:
> If colleges really wanted to improve the number of URMs in STEM, they could" – Jabar.

> Implicit in this statement is that institutions are either ignoring the problem or choosing not to address it, which is consistent with one key finding in the 2012 Hanover Research report: The retention of URMs in STEM is affected by the attitudinal and institutional barriers in higher education. There were several reasons for this, according to the researchers, of which three align with the observations of the participants in this study:
>
> - Inadequate outreach
> - Social bias and lack of support
> - Resource restraints and inequities

The participants stated that to increase URM interest in STEM, more outreach needs to be done in URM communities, more support is needed for faculty and staff who want to increase URM participation in STEM, and adequate resources need to be provided for programs to do just that.

### Theme 6: Giving Back to Others

Having been through STEM programs, all of the participants agree that giving back to the minority community is an important step in increasing URM interest in STEM careers. Most of the participants stated that as professionals they are giving back to their community by volunteering, tutoring, and returning to their community college to speak. Some serve on local community college advisory boards and community based boards. All stated that they do not "toot their own horn" about their success, but felt that community colleges should seek them out as role models. One participant felt that community colleges should do more to highlight URMs who graduated from their programs in recruitment brochures and other literature produced by the colleges. The concerns expressed by the participants suggest the need for URMs to find a way to become involved or expand their networks to include others like themselves. They want to become involved as well as be recognized for their accomplishments, creating the crosscutting opportunity of key finding 6:

> **Key Finding 6*:* The participants in this study were not involved with any of the minority professional affinity groups while attending community college**. Seven out of the eight participants were not involved in any of the professional affinity groups connected with STEM careers. This is amazing in that many of the national affinity organizations have mission statements that support increasing URMs in STEM fields, including
>
> - AISES–The mission of the American Indian Science and Engineering Society (AISES, 2011) is to substantially increase the representation of American

Indian and Alaskan Natives in engineering, science, and other related technology disciplines.

- NOBBChE–The mission of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (2011) is to build an eminent cadre of people of color in science and technology.
- SACNAS–The mission of the Society for the Advancement of Hispanics/Chicanos & Native Americans in Science (2011) is to foster the success of Hispanic/Chicano and Native American scientists—from college students to professionals—to attain advanced degrees, careers, and positions of leadership in science.

Could increasing involvement in and/or adding community college chapters of these types of organizations generate more URM interest in STEM careers? This may be an overlooked resource by many community colleges in addressing this national problem. All of the participants in this study except for one were uninvolved in professional affinity organizations. The outlier, Pelt, is the American Indian participant who attended a tribal college. He was involved with AISES (the American Indian Science and Engineering Society), a national organization that offered exposure and networking opportunities that positively impacted his STEM career. Concerning URM working professionals, a different participant stated:

> Most professional URMs disappear into the corporate world. There is a phenomenon that goes on the African American community of the educated, that they disappear and I could be one of those people for example that I am actually talking about. That we disappear into the corporate world – Jabar.

This phenomenon — as described by one participant — offers a compelling reason for community colleges to align with professional STEM affinity organizations.

## Theme 7: Tutoring

Tutoring is another theme that emerged from the lived experiences of the participants in this study. In this theme, respondents focused on describing the time spent in the tutoring center at their college. Although all of the participants stated that they were good in math and science, and liked math and science, tutoring was an important support system for most of the participants. Some used the service when having problems in a class, while others consistently used the service whether they needed it or not, as shared below:

> Like when I was in the science and the calculus and the physics and the chemistry classes, I didn't go home until my homework was done. I sat in the tutor lab, and if I needed help, they were there, and if I didn't, I would just sit there and did it. I didn't leave until my work was done – Eba.

Another participant commented that:

> The tutoring tables were helpful in those days with physics or maybe a math proof that I couldn't figure out – Ana.

Some of the comments were insightful:

> [I] started off in computer science and was taking all of these math classes. I ended up taking class after class [and] was getting help in the Teaching & Learning Center [with tutors]. After taking all of the [math] classes, I changed to major in math. While waiting for help, I would help others – Juan.

When discussing the support services that helped in completing the STEM curriculum, one participant stated:

> I would say tutoring. Now once in a while I might see the instructors, but really not that much. Tutoring, when I had some trouble in my classes -- Roa.

Each participant in this study had a different tutoring experience, but each experience was significant for all. From visiting the tutoring area for help, to just sitting at the tables without needing help from a tutor, to changing majors after mastering a subject being tutored, this support service had meaning for the participants. The underlying belief of the participants regarding the academic rigor of their program and the tutoring received is linked to key finding 7:

> **Key Finding 7: The participants in this study were successful in completing a STEM curriculum at their respective community college without having enrolled in a developmental math course**. In that many URMs are placed into developmental math courses, *this was a surprise finding*. It is also an important finding because it supports the notion that developmental math can be a barrier to URMs graduating from a community college with any type of credential or degree. Although developmental math was not a factor for the participants in this study, from a critical analysis perspective, it could be a significant barrier for the many URMs who attend a community college and may want to consider a STEM career, but get lost in the developmental track. Even without having developmental math courses, tutoring plays an important role in the STEM experience.

The final themes that emerged, peer mentoring and small class sizes, were expressed as being important, but consistently did not generate much discussion by the participants. This common experience was reflected in matter-of-fact way — in shared voices.

### Theme 8: Peer Mentoring

The participants who spent a lot of time in tutoring often found themselves helping other students with math or science homework as a peer mentor, another theme that emerged. One participant stated:

> I was a peer mentor; I enjoyed that opportunity a lot. I enjoy helping others even more and sharing the content – Ana.

### Theme 9: Small Class Sizes

All of the participants appreciated the small class sizes of their STEM program at the community college and many stated that the small class sizes enhanced their college experience. One participant shared that:

> By keeping the classes small, I was able to make the transition to learn the needed skills in my area – Lou.

Another participant described the small classes as being a plus because:

> You didn't get lost in the sea of people that you experience at large universities – Jabar.

A benefit of small class sizes as discussed by another participant was that:

> The class sizes were small enough that you get to know the people in your class – Lee.

According the Association of Community Colleges (2013), small class sizes is one of the top ten benefits of attending community colleges because the environment allows those attending to "grasp concepts, talk with instructors and classmates, and build

relationships." Winerman (2013) also writes that smaller class sizes allow a better opportunity for personal relationships with instructors.

## Summary

This chapter described the lived experiences of the eight URM professionals who completed a STEM program at a community college and discussed the nine themes developed and the seven underlying beliefs as key findings. The nine themes that had significant meaning to participants' lived experiences are: Instructors, Co-op/ Money, Motivation/Belief in Self, Community Engagement, Race, Giving Back to Others, Tutoring, Peer Mentoring, and Small Class Sizes. The responses of the participants to both the survey and interview questions supported the nine themes developed and data from the survey is woven throughout the study to support the themes.

There were two surprise findings in the study. The first was that none of the participants enrolled in or placed in a developmental math course. The second surprise finding was the lack of engagement of the participants in campus clubs and organizations. Both of the surprise findings did not correlate with the study's literature review on developmental education and student development theory.

Although fictitious names were used, the researcher interviewed actual people who attended and graduated from three different community colleges and one tribal college in the Midwest. The qualitative findings in this study suggest that although there are institutional systems in place that are used by URMs, being self-motivated is perhaps the determining factor in completing STEM programs in community colleges. In addition, based on the responses to the interview questions, the participants in this study are keenly aware that URM faculty members were basically absent in their programs, and

they suggested that this may be a barrier to URMs entering into these fields, a finding supported by the study's literature review.

# CHAPTER 5
# CONCLUSION

## Introduction

This study examined the experiences of URM STEM professionals who graduated from a community college with a degree or certificate in a STEM program. The research defined the problem, described the participants' experiences in their personal STEM journeys, and developed themes based on the participants' experiences. This chapter will briefly review the purpose of the study and the research design. The correlation to the literature review, theoretical framework, and future research, as well as implications for community colleges will also be discussed.

The purpose of this qualitative study was to describe the lived experiences of URM STEM students using a phenomenological methodology. The study consisted of a purposeful sample of eight URM students who had completed a community college STEM program and was working in a STEM or STEM-related career. There were three female and five male participants whose ages ranged from 25 years to 50 years old. This chapter is organized around the literature review: historical context, developmental education, critical race theory, community engagement and STEM, and community colleges and STEM.

## Correlation to the Literature

*Historical context*. The education of African Americans, American Indians, and Hispanics continues to be of concern in the United States. In this study, all but one of the African Americans attended segregated schools (Levine, 2011), the American Indian attended a tribal college in which math and science were not a focus (Boyer, 2012), and one Hispanic participant came from a marginalized school system while another overcame a language barrier. Although the participants were self-selected and the study cannot be generalized, the sample was representative of the types of students that attend community colleges, as was their experience in context as presented in the literature.

*Developmental education*. Researchers such as Hagadorn et al. (1999) and Dowd (2012) report that more than 50% of African American and Hispanic students start their college education in developmental math, and they note that the success in these courses is low. According to Sherwin (2011), this number increases to about 80% in all developmental courses for tribal colleges. In that math is the foundation of STEM programs, the effect of such statistics is that at best, very few URM students will choose or make it through a STEM curriculum at a community college. Students weak in math may not persist.

None of the participants in this purposeful sample took developmental math at their community college and they did complete a STEM program. It seems that developmental math does impact the URM STEM pipeline by limiting the number of potentially eligible students.

*STEM and race.* Discussions about STEM and race continue in many segments of U.S. society, and most agree that there is a lack of ethnic and racial diversity in STEM at

all levels — faculty, staff, and students. This lack of role models for URM students in STEM, the large number of URM students in developmental education, and the historical context of the URM educational experience in higher education is the intersectionality of race and STEM that creates a perpetual cycle of not increasing the URM STEM pipeline. How this intersectionality is addressed is important to the goal of increasing URMs in STEM programs and careers. That the participants in this study were successful in completing STEM programs without significant URM role models in the discipline is not unusual in that all URMs in the STEM workforce completed programs under the same conditions. An important observation is that the number of URM faculty in STEM disciplines is low, as is the number of URM students completing these programs. This statistic has not changed significantly in more than 30 years, and certainly not enough for the representation of URMs to approach parity with their presence in the U.S. population (McPhail, 2013).

*Critical race theory***.** The examination of institutional systems that may create barriers to URM students in higher education is an important aspect of critical race theory. For the last 50-plus years, there have been many well-meaning people and programs in higher education that want to increase minority representation in STEM. However, nationally, there is not a coordinated effort to sustain curricula or programs. More regional programs such as the MESA program in California and the National Science Foundation's Advanced Technological Education program have experienced success and have data to prove it, but we need more programs like those. As discussed in critical race theory, the dominant culture in higher education has a framework of individual responsibility (Gildersleeve, Croom, & Vasquez, 2011), which this researcher

purports is a barrier to community colleges adopting a unified approach to addressing the URM STEM problem. Any effort should be tied into a strong community engagement component.

*Community engagement***.** Forming partnerships and collaborations with URM groups in the community in which the community college is located are critical aspects of community engagement. Hence, recognizing, embracing, and welcoming the cultural and ethnic diversity of the students who attend the college and the community from which they come play a huge role in forming collaborations and partnerships. True engagement involves being inclusive, with all stakeholders at the table. True engagement also requires a diversity of stakeholders in the strategic planning and decision-making process. It is not an exclusive process where one group is deciding what is best for another group and then implementing a plan. In addressing the lack of minorities in STEM programs and careers, community colleges must be responsive to and respectful of URM community-identified needs (Taylor, 2009).

*Community colleges and STEM***.** An openness to change can transform community colleges into leaders in granting STEM degrees to URMs. This transformation will require pedagogies that overcome institutional barriers that do not support the success or completion of STEM programs, including having faculty members who reflect the community being served by the community college. Strategies to increase URM STEM graduates need to be intentional, inclusive, and sustainable.

Research by Bettinger (2012) indicates that only 14% of students who declare STEM as a major when entering college continue in STEM. A better understanding of why this is the case is needed to ensure that the programs are *challenging* and not

*discriminatory* to URM students. As indicated by Bensimon et al. (2012), "addressing the underlying structural and institutional problems responsible for such underrepresentation" is critical to long-term planning and sustainability for URM participation. Combined, almost 50% of community college students are URMs as defined in this research (AACC, 2013b). Tapping into this population will reap huge benefits for students while moving community colleges to inclusive excellence in STEM.

## Correlation to Theoretical Context

The narrative approach used in qualitative research has a psychological/ psychosocial philosophy underlying the lived experiences of the participants. The psychological, as discussed by Merriam (2009, p. 33), focuses on the "holistic" approach with four areas identified in sense making: cognitive, affective, motivational, and environmental.

Chickering and Reisser's (1993) student development theory is described as psychosocial, which takes into account "a series of developmental tasks or stages, including changes in thinking, feeling, behaving, valuing and relating to others and oneself" (p.2). In this study, an example of the above-noted changes is when Ana described her experience with an instructor who brought her out of her shell by teaching her to be assertive. This lesson stayed with Ana as she moved into her STEM professional career, as evidenced by her ability to give feedback on college recruiting to the company for which she currently works.

Chickering and Reisser created seven major developmental vectors of this theory: developing competency, managing emotions, autonomy toward interdependence, developing mature interpersonal relationships, establishing identity, developing a purpose

in life, and developing integrity. During the interview process, many of the participants connected with the seven developmental vectors. Examples include Jabar's autonomy toward interdependence as he experienced being part of a community, Pelt's experience in establishing his identity as an American Indian, and Lou using his time at the community college as a discovery process as he developed a purpose in life.

Implicit in Tinto's (2012) theory is that students need integration into academic systems, both formal (academic performance) and informal (faculty/staff interactions), as well as social systems, both formal (extracurricular activities) and informal (peer group interactions). Tinto states that "student success requires intentional, structured, and proactive action that is systemic in nature and coordinated in application." The individual, institution, and community must work together in order to create pathways for URMs to study/excel in STEM programs. Eba's experience was proactive and systemic as demonstrated in her mantra that practice makes perfect, as she integrated her academics with tutoring and work. Table 4.8 in Chapter 3 highlights the formal and informal academic and social systems of the participants.

As a framework, the themes developed in this study are inclusive of the strategies of Tinto, Chickering, and Reisser in the following ways:

1. Establish new relationships: Instructors, Peer mentoring
2. Develop a purpose in life and work toward that purpose despite obstacles: Motivation/belief in self
3. Be aware of appropriate support services: Tutoring
4. Demonstrate collaboration, cooperation, and teamwork: Community engagement
5. Manage financial barriers: Money/co-op

Another correlation to the theoretical context is Tinto's (2012) theory in which he states that student success does not happen by chance, but requires "intentional, structured and proactive action that is systemic in nature, and coordinated in application," an approach that complements what the participants in this study said.

## Limitations and Delimitations

Generalizability of the study to the general population is neither possible nor the goal of the inquiry. There are several factors that limited the generalization of this study. The first limitation is the size of the study. The research sample consisted of eight individuals, which is within range of the number of participants needed for phenomenological studies (Polkinghorne, 1989). However, all of the participants were from the Midwest and represented four colleges, two rural and two urban. There is the possibility that the findings may not be transferable to other community colleges within the Midwest or community colleges outside of the Midwest geographical area.

The second limitation is the criteria developed for participation in the study. Although the research method designed for the study was adhered to, outreach methods to the colleges, universities, affinity groups, professional organizations, and corporations were, for the most part, unable to secure a large number of participants for the study based on the criteria developed because of the inability to track community college STEM graduates. This was also a delimitation to this study. For example, the organizations contacted stated that it was difficult to identify URM professionals who graduated from a community college currently working in a STEM career. Many of the networks used in this study knew of URMs working in STEM, but could not identify those who received a certificate or degree from a community college curriculum. This

resulted in self-selection of the participants based on the limited tracking done. Perhaps it is possible to get the information through other methods than the one used in this study; however, time limitations for completing the study did not allow exploration of other methods. Further study with a different research design may be needed.

## Alignment with Theory and Best Practice

Community colleges need to be intentional in their approach to and strategies for attacking this problem by developing a process. Some scholars have discussed duplicating successful models across community colleges. Others state that because of the individual uniqueness of culture in each community college, duplication can be difficult and therefore implementing processes based on the culture of the college is a better option (National Academy of Sciences, 2010). The lived experiences of the participants in this phenomenological study included fostering relationships with instructors, making money through co-op, internship opportunities and work study, tutoring, peer mentoring, motivation/belief in self, community engagement, race, small class sizes, and giving back to others.

Based on his or her experiences, each participant shared one or two ideas as a framework to include in STEM programs geared toward URM students. Excluding overlap, the framework would:

- Have small class sizes
- Provide mandatory tutoring sessions
- Respect the time commitments of students who work and have families
- Provide social counseling on self-confidence and personal issues
- Include peer counseling from students who look like them and can provide support

- Offer math classes every semester
- Offer science classes every semester
- Have scholarships and internships
- Include programs that introduce students to URM professions working in STEM fields

The recommendations have a number of alignments with some of the programs discussed in the literature, from theory (Hanover Research Report, 2011, and National Academies of Sciences, 2010) to practice (MESA Community College Program, 2012). Table 15 lists the suggested characteristics to be included in the framework for an URM STEM program.

Table 15: URM STEM Program Framework

| Themes Developed | Participant Recommenda-tions | MESA Community College | Hanover Report (2011) | Nat'l Acad. of Science-community colleges (2010) |
|---|---|---|---|---|
| Tutoring | Mandatory tutoring | Student study center | Tutoring | Academic support |
| Co-op/Money | Scholarships and paid internships | Scholarships | Financial aid & scholarships | |
| Peer mentoring | Peer counseling | | Mentoring programs | Peer mentoring |
| Community Engagement | Professional URM speaker series | Links to professional organizations; advisory boards | Community outreach and partnerships | Articulation agreements; summer bridge programs |
| Race | Professional URM speaker series | | Inclusive & welcoming environment | |
| Small class sizes | Small class sizes | | | |
| Instructors | | | | |
| Motivation/ Belief in Self | | | | |
| Giving Back | | | | |
| | Family and work commitments | | | |
| | Social counseling | Counseling | | Career/social counseling |

| THEMES DEVELOPED | PARTICIPANT RECOMMENDA-TIONS | MESA COMMUNITY COLLEGE | HANOVER REPORT (2011) | NAT'L ACAD. OF SCIENCE-COMMUNITY COLLEGES (2010) |
|---|---|---|---|---|
| | Math every semester | | | |
| | Science every semester | | | |
| | | | Research objectives in cultural context | Undergraduate research |
| | | Assistance with transfer process | Facilitate transfers to 4-year colleges | |
| | | Academic Excellence workshops | | |
| | | Orientation | | |
| | | | Learning styles | |
| | | | Administrative STEM positions | |

The characteristics in Table 15 are taken from the themes developed in this study, the recommendations by the participants, and elements suggested by the Hanover Research report (2011), and the National Academies of Sciences. The characteristics of the Mathematics, Engineering, Science Achievement (MESA) program, which began in 1968, were included as a benchmark for best practices in a STEM program that is sustainable. In 2013, the *Huffington Post* (Rucker, 2013) named the MESA program as one of the top five community college STEM program for minorities. The MESA Community College Program (MCCP) provides science, technology, engineering, and math (STEM) academic development to educationally disadvantaged and URM students so they will excel academically and transfer to four-year institutions in calculus-based majors. MESA has been replicated in many states.

Table 15 indicates that tutoring and community engagement has the strongest alignment of practices and recommendations. As a theme, tutoring was important to the lived experiences of the participants, and they recommended it as an integral element of STEM programs for URMs. The next strongest alignments are with the themes of co-op/money and peer mentoring. Many community college students are low-income/first-generation students and this profile is also part of the STEM URM student experience. Financial support is needed, especially in STEM programs that generally take longer to complete. Peer mentoring may often be the only opportunity for URM students to interact with someone who looks like them.

The next strongest alignment in Table 15 revolves around race, the hallmark of community colleges because of the high percentage of URMs enrolled outside of minority serving institutions and tribal colleges.

Counseling, social and career, was not a theme that developed in this study or a recommendation by the participants as a characteristic. However, it was recommended by the National Academies of Sciences and is an important element in the MESA STEM programs. Other characteristics not mentioned by the participants included in Table 15 are: undergraduate research opportunities, learning styles, administrative STEM positions, orientation, and academic excellence workshops. Another characteristic worth noting is the administrative STEM position from the Hanover Research report (2011), which can ensure the viability and sustainability of the program. This researcher would describe all of the aforementioned characteristics as ones that were not part of the participants' lived experiences.

There are, however, two recommendations by the participants in this study that did not show up as a characteristic: family and work commitments, and math and science courses each semester. This is interesting in that the category of work and family commitments was an important part of the profile for all of the participants and ties directly back to scholarships and money. The experiences of the participants in this study are that four (or half) had family responsibilities; three were married; and seven worked while attending community college. Dealing with work and family commitments is a huge part of the community college experience that requires having systems in place to effectively and consistently minimize this as a barrier.

Based on the frequency of characteristics listed in Table 15, a framework for URM STEM programs should have at a minimum, the following:

1. Tutoring–structured help with coursework.
2. Co-op/money–paid internships, scholarships, and financial aid.
3. Peer mentoring–being a mentor and being mentored by someone who looks like the URM student.
4. Community engagement–collaborating and partnering with community organizations.
5. Race–having URM faculty, staff, and students well represented in STEM programs bolsters self-esteem and provides encouragement.
6. Counseling–social and career to offer support and guidance.

## Community College Leadership: A Personal Reflection

The open door philosophy remains the foundation of community colleges. The role of community colleges is very important to the educational health and economic vitality of the United States. The mission of community colleges is to serve the communities in which they are located by meeting the needs of the communities,

particularly the workforce, academic, and social needs. Community colleges are "responsible for stimulating economic development through service and educational programs" (Starobin, Laanan, Burger, 2010, p. 2). Projections are that the United States will not produce enough STEM graduates to meet the workforce and career needs of the STEM jobs available. The projections are worse for members of the URM population. It is critical that community college leaders look at ways to meet the STEM need, not only in local communities, but at the state and national levels as well.

This challenge to community college leadership in addressing the problem of increasing URM STEM graduates can be approached in a holistic way by understanding that programs that benefit URM students benefit all students. It is essential that community college leaders reflect upon their personal commitment and philosophy concerning educating the students who attend their institutions, as the skills and competencies needed to lead the community college enterprise into the future are multidimensional. Leadership will play an important role if we hope to educate and train more URMs in STEM careers, and various aspects of such leadership deserve attention.

## Community College Competency

This multidimensional foundational approach to leadership is complex, yet flexible and adaptable (Eddy, 2010, p. 33). In 2005, The American Association of Community Colleges (AACC) introduced six competencies needed for community college leadership of the future: organizational strategy, communication, resource management, collaboration, advocacy, and professionalism. A seventh competency – cultural competency – was added in 2006. At the core of cultural competency is diversity, inclusion, multiculturalism, equity, and community engagement (Ivery, 2009, p. 31).

Cultural competency is perhaps the most difficult to attain in college environments and academic cultures steeped in traditions that may not understand its real value. The question then becomes: Is the focus of leadership in the community college environment compliance-based (legal), business-based, or value-based?

Compliance-based leadership means that when leaders are uncomfortable, invoking federal and state laws is the norm, while business-based leadership means that leaders are focused only on the financial bottom line. Value-based leadership believes in the mission, vision, and values of the college and is focused on doing the right thing for all stakeholders. Value-based leadership is committed to finding solutions to issues across boundaries, experimenting with new ideas and taking those ideas to scale, and leading with courage. Perhaps this is why there continues to be the challenge of increasing URM presence in STEM programs. When it comes to serving the needs of URM students, living the mission, vision and values of the college requires deep courage.

## A Team Approach

In this study, the underlying belief is that cultural competency needs to be highlighted if progress in increasing URM representation in STEM is to be achieved. We know that URMs represent an untapped resource in the production of STEM graduates and, with committed leadership; community colleges can lead in this effort. Addressing this problem requires a team approach supported and driven by leadership that is willing to

- Advocate for the population that needs the help
- Provide the organizational strategy and resources needed to sustain efforts that are implemented
- Collaborate with internal and external stakeholders

- Understand the cultures in the community served
- Transform the community college culture toward change that supports policies and practices important to sustaining STEM degree attainment among URMs
- Live the college's mission, vision, and values

Community college leadership regarding URMs in STEM requires true community engagement that is respectful of all community stakeholders – students, faculty, staff, board of trustees, organizations, businesses, government, and others. Community college leadership also requires a commitment to improving URM student enrollment in STEM programs with adequate funding that can be sustained. Without community engagement and commitment, the cycle of low URM representation across STEM programs in community colleges will continue.

However, there are two important stakeholders who can provide a rich source of collaborative support to leadership in creating this vibrant, proactive shift in the STEM paradigm: faculty and students. Strong leadership for this challenge will engage STEM faculty members as partners while building inclusive pathways for URM students to enroll in and complete community college STEM programs. Faculty is an integral part in driving change in STEM programs and practices that can facilitate successful STEM programs and community college graduates, many of whom will transfer to four-year institutions.

In reflecting on the leadership approach and characteristics that could provide and sustain pathways that support URM students in STEM programs, this researcher posits that there are seven components of leadership that will help increase the number of URM students who enter into STEM programs at the community college level:

- Cultural Competency
- Communication Skills
- Holistic Approach
- Multi-dimensional Approach
- Community Engagement
- Committed Resources, and
- Courage to Lead

If community colleges want to improve the URM representation in STEM, leaders should incorporate these seven components in their skill set. The seven components of leadership that will sustain efforts and strategies to increase URM student representation in STEM are the framework for an environment that supports excellence in equity, diversity, and inclusion – and creates an opportunity for URM students to find pathways to STEM careers. These components are the recommendations of the researcher – not the participants in this study – based on the data from the research.

## Cultural Competency

With reference to URM students, community college leaders must be aware of two important factors:

- How their own personal values and beliefs affect their view of URM students.
- How their own biases and stereotypes affect their perceptions of URM students.

Whatever the community college states as its values, the leader must have the same values, must "walk the talk," and must demonstrate his or her commitment to those values. At the core, the leader's belief system must align with the community college's

values. Everyone has biases – the question is what we do with them. Leaders who take up the challenge of increasing URM students in STEM must understand that they are building a culture – not a program – that supports increasing URM students in STEM academic programs at community colleges. Cultural competency begins with leaders in the college owning their beliefs, values, and biases, and incorporating ongoing opportunities for the campus community to dialogue, learns and grow together in those beliefs. An environment that encourages conversations about race, gender, ethnicity, and culture will play a critical role in increasing URMs in STEM.

## Communication Skills

The ability to articulate the mission, vision, and values of the community college strengthens ongoing and open communication and connects the leadership with all stakeholders: students, faculty, staff, board of trustees, K-12 systems, service clubs, churches, philanthropic organizations, federal and state agencies, businesses, and organizations – the demographics of the community. The skills needed to facilitate an environment where all voices are heard and appreciated provide a framework of trust and appreciation essential to bringing people together around a common goal: increasing URM students in STEM programs. The role of leadership in community colleges includes "positioning themselves in the middle of the two-way flow of messages between the college and community constituencies about the changing educational needs" (Ivery, 2009, p. 27). In this case, the changing educational needs in many communities may lead to groups of people finding ways to increase URM participation in STEM programs. Educating, developing, retaining, and graduating students are the overall goals of

community colleges. Leaders should look for opportunities to communicate and share information to all stakeholders about their commitment to URM communities.

## Holistic Approach

Leading in a holistic manner is key to working with URM students and their communities. To reach these students, leaders must consider the whole student and what each brings to the college such as educational background, age, socioeconomic status, gender, race, and ethnicity. Many are working students with families; their college and family lives are woven together in ways that often cannot be separated. Not all students enter the doors of their community college with a strong belief in self or the motivation to succeed. Leaders should act as mentors to community college students – and encourage them to mentor other students. However, regardless of the circumstances of the student, community college leaders should consider developing, maintaining and expanding strategies that support student success by embracing a holistic leadership approach.

## Multi-dimensional Approach

Multidimensional leadership involves being aware of the complex development of different perspectives from a wide range of experiences (Eddy, 2010, pg. 59) that leaders bring with them to their roles. As the community college leader reflects on these experiences, growth takes place and the leader is able to think "outside the box" when leading the institution. The goal of increasing URM participation in STEM requires "outside the box" thinking. This flexibility undergirds the multi-dimensional approach in this way: As leaders learn, they change based on the needs of the institution in response to the needs of the community and the students who attend community colleges. This strength enables the college and the community to change together and is important to

achieving an increase in the number of URM students who enroll in STEM courses and graduate with a STEM degree or certificate.

## Community Engagement

Retired community college president Will "Bill" Giddings of Northwest Iowa Community College offered the following advice – in part – to other community college CEO's: "…as a community college president, don't ever forget that community is our middle name" (American Association of Community College, 2011). Community engagement is one of the cornerstones of the new open door community college (Myran, 2009, p. 8), and it is imperative that community colleges serve all segments of the community, including URM students. Community engagement requires that leadership be inclusive in its collaboration with and advocacy of all stakeholders. At times this will be uncomfortable. However, with committed leadership, community engagement can provide a strong framework that allows members of the community to connect with the college as active and engaged participants. Leadership that is committed to engaging the community must understand and recognize that all members of the community are included in the "mission, vision, and values" of the community college. Collaboration between the community college and the community it serves benefits everyone. Community college leaders have a responsibility to include underserved minority populations of the community in dialogue, discussion, and decisions made regarding STEM and other programs. True engagement is inviting members of the community to participate from the beginning to the end of the process. Community colleges are accountable to their communities.

## Committed Resources

The allocation of resources for any program, initiative, or department requires inclusion in the college's strategic plan. Leaders must communicate the funding priorities of the institution – and ensure that mandates are funded. Being committed to increasing minority participation in STEM requires sufficient resources to:

- Retain and hire talented instructors and administrative staff
- Offer services such as tutoring and mentoring
- Purchase equipment for both innovative and classic research and experiments
- Offer paid co-op and internship opportunities, and
- Schedule small class sizes

This commitment must be imbedded in the infrastructure of the college and sustainable over many years. Committed resources means taking on the challenge to solve this national problem and being strategic in helping the college community understand that committing resources is a part of solving the URM STEM problem.

## Courage to Lead

The changing demographics of the United States have created challenges and opportunities for community college leaders, especially in the area of preparing students for STEM careers. Research continues to report that the number of URM students going into STEM careers is low, and the number will continue to be low without significant intervention. Although scholars don't agree on the reason for the low enrollment and completion of STEM programs, the situation creates an opportunity for community colleges to lead in this area. As with most change, there will be resistance from some members of the community who may not agree with programs that focus on URMs. In

addition, the political climate on campus, limited resources, and weak commitment to educating URM students is also prevalent in the community college academy. However, the mission of community colleges is to educate and serve the communities in which they reside. Many community colleges are located in urban communities where the majority of the students are URM students as defined in this study. Providing programs and services to train and support URM students in STEM is not only the right thing to do for the students and community, but the best thing to do to ensure a competitive future for the country. Community colleges can lead this transformation – with courage.

For leaders, it takes courage to survey the community college campus, see the lack of diversity in STEM programs and actually say "Hold it, let's assess our STEM programs, and see how we can increase diversity in the student body and faculty ranks." The definition of diversity in the academy today is quite broad and includes almost every dimension of individual differences humanly possible. However, we know that the following eight dimensions of diversity, when managed effectively, have positive outcomes on organizational effectiveness:

1. Ability
2. Age
3. Ethnicity
4. Gender
5. Race
6. Religion
7. Sexual orientation
8. Socioeconomic status

Three of the eight dimensions – ethnicity, race, and socioeconomic status – were addressed in this study. It takes courage, as a leader, to address the disparity of race, ethnicity, and socioeconomic status in academic programs on campus in order to increase the URM student representation in STEM programs. It takes courage to live the stated mission, vision, and values of the community college.

## Recommendations for Future Research

There are several areas recommended for future research on this topic.

1. One of the best models for community college STEM programs in the United States is the MESA Minority Community College Program. A key component of the program is a link to professional STEM organizations. The literature is silent on this connection and research on the impact this strategy can have on increasing URM interest in STEM is needed.
2. There are many undecided URM students entering community colleges every semester. Understanding how to tap into this resource of potential students might be another way to increase URM representation in STEM fields.
3. Scholars agree that the best time to introduce STEM careers and concepts is in elementary school. But the role/mission of community colleges is to meet the needs of the community in which they serve, and many of the students who enter the doors of community colleges may not have been introduced to STEM in elementary school or have a strong STEM educational foundation. In addition, carrying out the community college mission includes meeting the needs of older, nontraditional students who attend community colleges to learn new skills. More research is needed on how to align this reality with the need for well-trained STEM community college graduates.
4. New barriers are being erected that will make it even more difficult to tap into potential URM talent (McPhail, 2013). In the report *Confronting The "New" American Dilemma,* The National Action Council for Minorities in Engineering (NACME, 2008) identified the following barriers:

- The rising cost of tuition
- The decrease in financial aid funding
- The increase in non-federally backed loans, resulting in rising student debt
- The attack on using affirmative action as a means to diversify colleges and universities
- The elimination or reduction of early intervention programs for URM and low-income students

Additional research into the barriers, and corrective action needed to remove the barriers, is imperative if the U.S. is to remain a global leader in STEM.

## Summary

This phenomenological qualitative study examined the lived experiences of eight URM STEM graduates who had from two years to more than 20 years of experience working in a STEM or STEM-related career. The study provided insight into the lived experiences of the eight participants. There were nine themes developed that impacted the lived experiences of the participants: instructors, tutoring, peer mentoring, co-op/money, motivation/belief in self, community engagement, race, small class sizes, and giving back to others. The nine themes resulted in seven key findings.

As found in the literature review, and as stated by one of the participants, the underrepresentation of minorities in STEM is not a new problem. Therefore, the recommendations of the participants in this study were compared with best practices in a sustained URM STEM program-and coupled with recommendations from promising research. The nine themes and seven key findings that emerged from the study offered an understanding of the URM experience of completing a STEM program in midwestern

community colleges. By embedding these themes into the culture of community colleges, community college leaders can potentially increase the number of URM students who complete STEM programs.

Based on the experiences of the participants in this study, STEM programs are hard, challenging, demanding, and require a source of income while enrolled. It is important that the faculty and staff at community colleges understand that URM students enrolled in STEM programs need co-op or internship opportunities to help them complete their programs. URM students in STEM are keenly aware that they have chosen an educational path that lacks diversity, but their motivation/belief in self helped them through the process.

## Conclusion

The researcher of this study learned that the best strategies for increasing the representation of URMs in STEM involve the broadening of pathways, not a pipeline. The term *pathway* is more appropriate because, as in this study, each participant embarked on a different path to completing his or her STEM program. Their experience was a multidimensional journey interconnected by common themes–the essence of their lived experience–discovered through individual interviews.

In reflecting on the purposeful sampling of this phenomenological research, the researcher discovered that developmental math was not a part of the participants' STEM experience. Although the math experience of each participant varied based on his or her K-12 experience, each one liked math, and upon entering the community college environment, each was well prepared with a solid math foundation. This has given the

researcher a greater understanding of the challenge that students may face with current pedagogies if their college experience starts with developmental math.

The researcher also learned that although community college scholars and practitioners know that most students receive financial aid and work part-time jobs while enrolled, the policies and practices at most community colleges do not reflect that. Current federal financial aid regulations and attendance policies across academic divisions can be barriers that URM students must negotiate. Policy makers and community college leaders must address these issues.

According to this research, I learned that instructors play a huge role in students completing STEM programs. Can you imagine the impact of having more minority instructors in community college STEM programs? Perhaps this is the best answer to the question as to why there has not been an increase in URM students completing STEM programs. Instructors are very important and the key to bringing diversity into this area.

The themes developed and key findings from interviews with the participants in this study were based on their personal experiences. Responding to the evolving diverse voices of students who have completed a STEM journey is an important step in developing strategies to increase the number of URMs in STEM. Now, more than ever, is the time for community colleges to commit the resources needed to support and encourage the untapped pool of URM students to pursue STEM careers.

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# APPENDIX

## A: IRB Approval Letter

To: Dr. Gunder Myran & Ms. Linda Moore Holoman

From: C. Meinholdt, IRB Chair

Re: IRB Applications #120503 (Title: Broadening Minority Participation in STEM (Science, Technology, Engineering, Math) Careers: A Framework to Strengthen the Community College Pipeline)

Date: August 10th, 2012

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, "Broadening Minority Participation in STEM (Science, Technology, Engineering, Math) Careers: A Framework to Strengthen the Community College Pipeline" (#120503) and determined that it is *exempt – 1A* from committee review. This exemption has an expiration date three years from the date of this letter. As such, you may collect data according to procedures in your application until August 10th, 2015.

It is your obligation to inform the IRB of any changes in your research protocol that would substantially alter the methods and procedures reviewed and approved by the IRB in this application. Your application has been assigned a project number (#120503) which you may wish to refer to in future applications involving the same research procedure.

Finally, we wish to inform researchers that the IRB requires follow-up reports for all research protocols as mandated by title 45 of the Code of Federal Regulations, Section 46 for using human subjects in research. The follow-up report form is available from the Ferris website: http://www.ferris.edu/htmls/administration/academicaffairs/vpoffice/hsrc. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let me know if I can be of future assistance.

# APPENDIX
# B: E-MAIL RECRUITMENT LETTER

My name is Linda Holoman, and I was referred to you by (name). I am enrolled in the Doctorate in Community College Leadership Program with Ferris State University, located in Big Rapids, Michigan and I am contacting you because I am starting the research phase of my dissertation - the focus of which is broadening STEM participation for underrepresented minorities (African Americans, Latinos, and American Indians) in community colleges. My dissertation is a qualitative one, and will include interviews of approximately 10-12 STEM professionals regarding their community college experiences and journey. I would like your help in identifying potential participants for the study - perhaps one or two professionals. The criterion for participating in the research is that the individuals have:

1. Is a member of one of the following ethnic/racial groups: African American, American Indian, or Hispanic/Latino.
2. Graduated from a community college with a degree/focus in a STEM area.
3. Are currently working in a STEM or STEM related career.

Of course, you may have questions about the research of which I am more than happy to answer. I know that you are very busy, and I would love to speak with you personally by phone if that would help you feel more comfortable. Please advise me of the best time to contact you. I am passionate about my research, and am eager to share and receive feedback and insight from professionals like you around my topic. I would like to start the interviews as soon as possible.

Regards,

Linda Moore Holoman
Equity Officer & Director of Diversity & Inclusion Delta College
Doctorate in Community College Leadership Program – Ferris State University

# APPENDIX
# C: LETTER OF INVITATION

You are being asked to participate in a research study that will focus on minorities who graduated from community colleges *and* completed an STEM academic curriculum at the community college. Specifically this study will document the journey of 6-8 individuals in order to create a narrative of their educational journey. In addition, this study will look at the math courses you have taken – which is considered a gateway course for science majors – to document your math pathway while enrolled in a community college. The research will include a 10-question survey about your math experience, which will be followed up with a one-on-one phone or in person interview. The data analysis process for this research will be narrative – the study of your experience through stories.

Participants for this study will be selected in one of two ways: By contacting select community colleges that offer STEM programs and are interested in increasing minority student graduation from STEM programs; or by contacting affinity organizations whose membership include professionals that have graduated from a community college STEM program. The following organizations will serve as resources for this research: The American Indians Science & Engineering Society (AISES), The National Organization for the Professional Advancement of Black Chemist and Chemical Engineers (NOBCChE), The Society for the Advancement of Hispanics/Chicanos & Native Americans in Science (SACNAS), and the National Action Council for Minorities in Engineering (NACME). Your participation in this study is voluntary and is anonymous.

Your responses to the initial survey questions and the subsequent interview are for my Doctorate in Community College Leadership at Ferris State University research dissertation. A summary of the results will be shared with any person who requests a copy of the study.

I have taken great strides to develop the survey with a simple design which will take approximately 15 minutes to complete. The subsequent interview questions are designed to elicit descriptive information that will provide a rich narrative for inclusion in the research. The interviews will take place by phone, SKYPE or face-to-face. It is anticipated that there will be approximately two interview sessions no more than one hour each. Your participation is valued and appreciated.

Please complete the on-line survey NO later than November 30, 2012. To participate click the following link: http://www.surveymk.com/s/STEMMath. You indicate your voluntary agreement to participate by completing the STEM Math Survey. If you have any questions, feel free to call me at 989-686-9269. Please forward any concerns regarding this research to the Ferris State University Human Subjects Research Committee:

Dr. Connie Meinholdt, Chair – Institutional Review Board
ASC – 2072, Ferris State University
Big Rapids, MI 49307
PHONE 231-591-2759
E-mail : IRB@ferris.edu

# APPENDIX
# D: SCRIPT FOR VERBAL INVITATION FOR INTERVIEWS

Hi, this is Linda Holoman, from Ferris State University's Doctorate in Community College Leadership program. How are you doing today? I would like to thank you for taking the online STEM math survey and for agreeing to participate in my research project. Your voice and educational experience is critical to this research and I appreciate your participation. The second step of this research project is to ask you a series of questions about your community college experience as you matriculated toward your associate degree in a STEM major. This interview should take about one hour. Are you ready to begin? Ok, let's get started.

# APPENDIX
# E: INFORMED CONSENT

You are being asked to participate in a research study that will focus on minorities who graduated from community colleges and completed a Science, Technology, Engineering and Math (STEM) academic curriculum at a community college. Specifically this study will document the journey of 6-8 individuals to create a narrative of their educational journey and to assist in developing a framework of what contributed to their success in STEM fields. In addition, this study will look at the math courses you have taken– which are considered gateway courses for science majors - to document your math experience while enrolled in a community college.

The research will include a 10-question survey about your math experience, which will be followed up with a one-on-one phone or in person interview about your community college experience. The survey should take about 15 minutes to complete and the one-on-one interview should take about 2 hours to complete over a course of 1-2 separate interviews. It is also possible that the researcher may need to contact you for follow-up or clarification questions during the analysis of the data collected.

Your identity will remain anonymous in the research findings and requests for results of the study will be available to you within these restrictions. Your privacy will be protected to the extent allowable by law.

You have the right to choose not to participate in this study, refuse to participate in certain procedures of answer certain questions or may withdraw from this research study at any time without penalty.

Any questions or concerns regarding this research should be directed to Linda Holoman, 989-631-7679, lholoman@delta.edu. If you have concerns about how the researcher has conducted the study, including recruitment, the surveys, or the interviews, please contact Ferris State University's Institutional Review Board:

Dr. Connie Meinholdt, Chair - Institutional Review Board
ASC – 2072, Ferris State University
Big Rapids, MI 49307
PHONE 231-591-2759

E-mail: IRB@ferris.edu

By signing this consent form, you acknowledge that you have freely consented to participate in this study and that your participation is voluntary. An electronic signature is acceptable. Please return form via e-mail to lholoman@delta.edu.

Signed

Name_____Date_____

Printed name_____

# APPENDIX
# F: INITIAL INTERVIEW QUESTIONS

1. Please describe your community college experience.
2. What worked well for your educational journey? What would you say were barriers for you?
3. Can you describe the programs and services that were offered at your community college that you think connected with you so that you could complete the STEM curriculum?
4. Tell me about the programs and services, both academic and co curricular, that you feel contributed to you completing your STEM program at the community college level.
5. Tell me about your math experience at the community college.
6. What role do you think math plays in the completion of STEM academic programs at community colleges?
7. How do you feel about the current representation of minorities in STEM fields in the United States?
8. Were any of your instructors a member of a minority group (African American, American Indian, or Hispanic)?
9. What are your thoughts on the minority community's participation in STEM efforts at your community college?
10. What role models emerged from your experience that helped you transition to the next level of your STEM career or education?
11. How do you feel student access contributes to minority participation in STEM curricula at community colleges?

# APPENDIX
# G: FOLLOW-UP QUESTIONS

1. Based on your community college experience, what is your opinion on how community colleges can broaden minority student participation in STEM academic programs and curricula?
2. Was there ever a time when you felt that the minority community really understood the impact that a STEM education would have on the overall health and growth of their community? Please share your thoughts and observations.
3. What do you think the ideal STEM curriculum at a community college should look like?
4. What would a successful STEM model for underrepresented minorities in the U.S. look like?
5. From what you know about yourself, do you think that you could be an advocate for engaging and broadening minority participation in STEM? Please explain.
6. What are some of the ways you think that community colleges can increase the visibility of successful minorities in STEM careers to younger students in community colleges?
7. Based on our discussions, is there anything else that you would like to add concerning this topic?
8. In your opinion, how do/or should community colleges collaborate with their communities to strengthen scientific literacy in the U.S. of underrepresented minority groups?

# APPENDIX

## H: STEM MATH SURVEY – ACCESS

(www.surveymonkey.com)

On the following pages, are questions about your math educational experience starting in high school up to and including community college. Your answers will help evaluate the math completion level of community college graduates in STEM programs. The survey is designed for individuals who completed a community college STEM academic program and successfully completed a four year degree. You are receiving this survey because you meet that criterion. Your answers to this survey are **anonymous**. We will have no way of linking your answers back to you individually. There are six questions on this survey and it should take about 10-15 minutes to complete. For the purposes of this survey STEM is defined as science, technology, engineering and math academic programs and careers.

1. Please describe how your background fits into the above definition of STEM.

2. Please check the type of math classes you took in high school, and indicate the final grade received in the class.

| Class | Grade |
|---|---|
| ___Pre-algebra | ___A ___B ___C ___D ___F |
| ___Algebra | ___A ___B ___C ___D ___F |
| ___Geometry | ___A ___B ___C ___D ___F |
| ___Trigonometry | ___A ___B ___C ___D ___F |
| ___Pre-calculus | ___A ___B ___C ___D ___F |
| ___Calculus | ___A ___B ___C ___D ___F |
| ___Statistics | ___A ___B ___C ___D ___F |
| ___Differential equations | ___A ___B ___C ___D ___F |

3. Did you take developmental math courses in community college?

   _____Yes _____No (Go to question 5)

   If yes, at what level did you begin the developmental sequence and what grade did you receive?

| Class | Grade |
|---|---|
| ___Basic Math | ___A ___B ___C ___D ___F |
| ___Pre-algebra | ___A ___B ___C ___D ___F |
| ___Algebra | ___A ___B ___C ___D ___F |

4. For each developmental math course enrolled in, rate your overall level of satisfaction with the developmental instruction on a scale from 1-10, with 1 being dissatisfied and 10 being very satisfied (Circle the number that corresponds with your selection).

   Basic Math: If the rating is from 1-3, please explain why you were dissatisfied

   Pre-Algebra**:** If the rating is from 1-3, please explain why you were dissatisfied

   Algebra**:** If the rating is from 1-3, please explain why you were dissatisfied

5. Please check the college level math classes you took in community college and indicate the final grade received in the class.

| Class | Grade |
|---|---|
| ___Geometry | ___A ___B ___C ___D ___F |
| ___Trigonometry | ___A ___B ___C ___D ___F |
| ___Pre-calculus | ___A ___B ___C ___D ___F |
| ___Calculus | ___A ___B ___C ___D ___F |
| ___Statistics | ___A ___B ___C ___D ___F |
| ___Differential equations | ___A ___B ___C ___D ___F |

6. Below are examples of the types of support services available at most community colleges. Please identify the services you participated in and indicate how likely the service contributed to your completion of math at the community college (feel free to write a comment in the box).

| | Definitely (1) | Likely (2) | Unsure (3) | Unlikely (4) | Definitely Not (5) |
|---|---|---|---|---|---|
| Tutoring | | | | | |
| Study groups | | | | | |
| Special topic workshops | | | | | |
| Math seminars | | | | | |
| Peer tutoring | | | | | |
| Instructor office hours | | | | | |
| Mentoring | | | | | |

**Demographic Information:**

Age: _____
Ethnicity/Race: ___(1) African American __ (2) American Indian __ (3) Hispanic

Degrees attained (check all that apply):
___Associates in Arts ___Associates in Science __Associates in Applied Science
__Associates in General Studies __Bachelors Degree __Masters Degree
__Doctorate Degree ____Other:_____

Area of country of the community college attended:
_____Midwest _____East _____South ____West
_____ Northwest _____Southwest _____New England
_____ Other _____

***Thank you for taking the time to complete this survey***