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College Success: An Exploratory Study of How Underrepresented Minority Students Enter and Persist in STEM Programs

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PERSIST IN STEM PROGRAMS**

by

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Abstract

Without the proper academic preparation and cultural capital, underrepresented

minority students may not find their path to pursuing science, technology, engineering, or

math (STEM) degrees. To gain a better understanding of how underrepresented minority

students experienced college success, this study examined how they entered a STEM

program of study and persisted in the program beyond their first year at the university.

Three important contexts presented the greatest barriers to persistence: low

socioeconomic status, first generation status, and under-preparation in math.   Participants

within these contexts were enabled to find a path to attend college and persist with

targeted support and advice from "cultural capital agents" in secondary education and

college. These cultural capital agents advocated for students, advised them towards

STEM academic enrichment opportunities, and developed the students' cultural capital.

The support of the cultural capital agents coupled with student engagement in high

impact socio-academic activities (for example: college transition programs, research

assistantships, membership in student academic organizations) helped students to persist

in STEM. By providing focused educational efforts designed to support

underrepresented minority students to enter STEM fields of study and to persist towards

timely degree completion, we can create a more diverse STEM workforce.

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Chapter One - Introduction

Background

One of America's founding fathers, Thomas Jefferson, believed that the then young nation's survival as a democracy rested upon its success in educating its citizens. Jefferson recognized that the control of power by the wealthy posed a threat to America's democracy and instead strived for the diffusion of learning. In the 1818 Report to the Commissioners for the University of Virginia, Jefferson (1818) outlined the purpose of higher education:

> To form the statesmen, legislators and judges, on whom public prosperity
>
> and individual happiness are so much to depend; To expound the
>
> principles and structure of government, ...and a sound spirit of legislation,
>
> which...shall leave us free to do whatever does not violate the equal rights
>
> of another; to harmonize and promote the interests of agriculture,
>
> manufactures and commerce...; to develop the reasoning faculties of our
>
> youth, enlarge their minds, cultivate their morals, and instill into them the
>
> precepts of virtue and order; to enlighten them with mathematical and
>
> physical sciences, which advance the arts and administer to the health, the
>
> subsistence and comforts of human life; and, generally, to form them to
>
> habits of reflection and correct action, rendering them examples of virtue
>
> to others and of happiness within themselves. These are the objects of that
>
> higher grade of education, the benefits and blessings of which the

Legislature now propose to provide for the good and ornament of their

country. (p. 435)

His purpose was clear and he remained focused on outlining the necessity of

education to achieve democracy. His efforts resulted in the establishment of a system of

public education in Virginia that would greatly expand the access of education to

common men as opposed to only educating the elite.

In the United States, the ideology exists that each citizen has equal opportunity for

social-economic growth through public education. The concept that educational

attainment will improve a student's future economic status and provide each citizen with

social mobility remains unchallenged. Sorokin (1927) posited in the early twentieth

century that mobility may be achieved through education and degree attainment and this

belief has become widespread and paralleled in both sociological and political theory

wherein it is perceived as a social mechanism that facilitates or is a part of meritocracy

and reinforces the social replication of position and class. The assumption exists that

because we fund public secondary and higher education, we indeed provide a means of

equal education opportunity, yet it may not be possible for the underprivileged to break

free of their social position. The general public has come to believe that low achievement

is a result of personal laziness and/or ineptitude. For those whom the current public

education system serves, the belief stands that their personal achievement is solely

attributed to individual hard work, scholastic ability, and merit. The situation we are left

with is one in which the achievers cannot fathom or admit to any social or economic

privilege they may have leveraged within the system and those who fail to achieve absorb

the blame for their cognitive inability and lack of academic success. In turn, a lack of

educational attainment continues to disadvantage citizens in their ability to obtain higher paying jobs or careers, lowering their potential work-life earnings, and locking them into low socioeconomic status and/or poverty.

Conceptual Underpinnings for the Study

It is a common American belief that our higher education system is considered a ladder of opportunity that will yield financial returns and upward mobility (Aronowitz, 2000; Grubb, 1985; Grubb & Lazerson, 2005; Lucas, 2006). Grubb and Lazerson (2005) stated, "Education has, in so many places, carried the hopes of civilization…" (p. 313). As comprehensive community colleges flourished in the United States we began to reinforce our belief systems that the ladder of opportunity, mobility through higher education, was possible for all citizens since college was seemingly available for all citizens. In the 1970s we saw minorities and other underrepresented students gain increased access to higher education through many of these tertiary institutions. But, access to two-year colleges was not necessarily equated with students completing associate degrees and/or transferring to four-year institutions to complete a bachelor's degree. In an examination of the role of socioeconomic status and race in students' track mobility, students of color were more likely to move to lower tracks of education than Whites (Bergersun, 2009). Many minority and underrepresented students that have the desire to attend public universities may be tracked into either community colleges and often times expensive private, two-year colleges simply because they do not understand the difference between the range of institutions: private colleges, community colleges, state universities, and/or research universities. With the increase of vocationalism (Grubb, 2006), preparation of workers for careers through higher education institutions,

there is a hierarchy of vocational education programs ranging from the two-year certificate that yields work in low-end jobs to the elite four-year bachelors of science from an engineering program at a research institution. Vocationalism has had effects on equity where,

> The expansion of access, particularly to universities, has extended
> education to groups that previously had not had much chance at higher
> education, including working class, minorities, and immigrants; the goal
> of College for All has promised a new form of potential equity. But
> greater access has not meant equitable access. About 25 percent of each
> cohort in this country, and even a higher percentage of low-income, black,
> and Latino students, still fail to complete secondary education, even as
> there have been efforts to expand higher education – thereby increasing
> the variance of schooling attained. (Grubb & Lazerson, 2005, p. 312)

Greater access in this context does not necessarily translate into equal access for all to the same institutions; particularly the top tier universities that offer programs of study that are required for elite careers. Minority underrepresentation in the science and engineering educational pipeline leads to the low participation rates of minorities in science and engineering occupations (Babco, 2001; Engineering, 2011; Huang, 2000; Lehming, 2002; Marrett, 2011; Slovacek et al., 2011). With this in mind the National Science Foundation provides funding to actively increase participation of underrepresented minorities into science, technology, engineering, and mathematics (STEM) programs as a means of increasing the diversity of the workforce in science and engineering fields as well as remaining competitive in the global scientific arena.

Undergraduate enrollment in four-year institutions rose to 9.4 million students in 2008 (Snyder, 2011). With the increase in enrollments, there was an increase in minority students but the percentage of bachelor's degrees awarded in science and engineering (all fields of study) to underrepresented minority students has remained static. Research and doctorate-granting universities produce most of the undergraduate engineering degrees, graduating 78 percent of engineering undergraduates in the year 2000 (Lehming, 2002). It is therefore quite important to learn what these institutions can do to improve access for underrepresented minority students to enter science and engineering programs as well as understand how to best support student persistence to degree completion.

College readiness is generally measured by achievement tests (i.e. SAT, ACT) or placement tests that are designed to assess a student's academic skills in math, English, and/or reading comprehension. Students who do not place into college level classes generally require remedial classes to prepare them for success in college level courses. In many cases, first generation students, minorities, and students of low socioeconomic status are also considered to possess factors that place them at-risk of not persisting in college due to a lack of what Bourdieu (1986) referred to as cultural or social capital. Bourdieu (1986) defined social capital as the soft skills of reading systems, understanding how to navigate them by learning how to access important social networks. Tinto (2006) envisioned a model of developing social support within an educational community along with "the capacity of institutions to establish educational communities that involve all students as equal members" (p. 4). In a manner similar to Bourdieu, he emphasized the importance of developing social skills (capital), especially for first generation college students. Bourdieu (1986) and Tinto (2006) made the point that, in addition to academic

preparation, there remains a need to simultaneously help students develop cultural capital in order to prepare them for college success. Student success within this context can be defined as academic progress or student persistence coupled with individual development while working towards an undergraduate degree in science, technology, engineering, or mathematics.

The Nation's Current Economic Climate

Recently in the United States, it seems all too common that policy makers are reducing the amount of federal, state, and local expenditures to fund the public good of education. The National Commission on Community Colleges (2008) reported with the tightening of state budgets, higher education will suffer from being underfunded. Coupled with the budget reductions in higher education, there is increasing pressure on the part of institutions to improve educational outcomes in the form of graduation rates at both two- and four-year institutions and to report these accountability measures.   Tinto (2006) characterized the situation this way: "At the same time, as the environment for higher education has changed from one of plenty to one of diminishing resources, there has also been a heightened focus on the part of the institutions and states alike on increasing the rate at which students persist and graduate from both two- and four-year colleges and universities" (p. 2).

In 2009 President Obama wrote an article, *Rebuilding Something Better*, in which he set the following goal:

> In an economy where jobs requiring at least an associate's degree are
> projected to grow twice as fast as jobs requiring no college experience, it's
> never been more essential to continue education and training after high

school. That's why we've set a goal of leading the world in college degrees

by 2020. (Obama, 2009, para. 8)

This goal was set during our country's biggest economic recession since the Great

Depression, at a time when the public is least likely to want to fund education or invest in

the infrastructure of our nation. It is also during a time the nation wants to retain a

competitive advantage relating to innovation in science. The National Science Board's

annual science and engineering indicators (Lanzerotti, 2010) reported that demographic

projections for 2010-2050 predict the strongest increase in the Hispanic minority group

population (19%) while the white college-aged population are expected to decrease by

20%. This trend provides a new challenge to United States. In order to maintain

innovation in science and engineering it will require recruiting and educating traditionally

underrepresented minorities and women into STEM programs especially in engineering,

computer science, and physics, which are historically dominated by white and Asian men

(Lanzerotti, 2010). Ideally, leaders in higher education can learn what factors contribute

to minority student persistence in STEM majors and how they can better support less

prepared students when they recognize that they are particularly challenged in their first

year of college. As Tinto (2006) posited,

> When the issue of student retention first appeared on the higher
>
> educational radar screen, now some 40 years ago, student attrition was
>
> typically viewed through the lens of psychology. Student retention or the
>
> lack thereof was seen as the reflection of individual attributes, skills, and
>
> motivation. Students who did not stay were thought to be less able, less
>
> motivated, and less willing to defer to the benefits that college graduation

was believed to instill. Students failed, not institutions. This is what we

now refer to as blaming the victim. (p. 3)

When students drop out of college, it seems common to believe that it was related

to the individual as opposed to examining the social, political, or structural aspects of

education. Instead of reducing class barriers during the transition to adulthood, the

postsecondary education system is more likely to reproduce inequalities (Aronson, 2008;

Grubb & Lazerson, 2005). At this juncture it seems pertinent to reframe the question,

what is the purpose of education? How can we achieve true democracy of education?

Will we define our nation's educational success simply by the number of students who

have access to postsecondary programs or by truly providing all citizens with a quality

education in a diverse range of programs of study (including elite programs)?

Educational Landscape of New Mexico

The state of New Mexico is located in the southwestern region of the United

States, bordering Mexico. The United States Congress admitted New Mexico as the 47th

state in the Union in 1912, making it a relatively young state. New Mexico's population

of just over 2 million residents predominantly resides in urban areas with 33% of the

population living in rural areas. The state is a minority-majority state and has the largest

percentage of Hispanics (46%) of all states. As reported by the U.S. Census (2010), the

other ethnicities in the state include: White, non-Hispanic (40%), Native American

(almost 10%), Blacks (2%), and Asians (just over 1%). The median family household

income in 2009 was $42,000 (Census, 2010) with about 20% of families living below the

U.S. poverty levels. Higher poverty levels result in an increased reliance on schools to

provide free and reduced priced meals for students in need. The state's student

demographics, including its many English language learners, potentially impact the number of students who successfully transition into higher education.

The state's report, *Ready for College 2010: An Annual Report on New Mexico High School Graduates Who Take Remedial Classes in New Mexico Colleges*, provided data that helped to illustrate the current education situation relating to college readiness (Winograd, 2010). Of the New Mexico high school graduates who attended college in New Mexico between 2000-2009, an average of 49% (N=7,903) took a remedial class in math and/or reading. This indicates that the public, secondary education experience did not prepare about half of its students for college level classes. As outlined in the report, "The high number of students who need remediation indicate that students need to be better prepared and that the alignment between high school and college needs to be improved" (Winograd, 2010, p. 27).

When looking at the percentage of New Mexico public high school graduates who took remedial college classes by ethnicity in 2009 we see 68% of Native Americans, 54% of Blacks, 53% of Hispanics, 32% of Whites, and 29% of Asians. This suggests that secondary education is challenged when it comes to serving minority students. Native Americans were twice as likely as Whites or Asians to need remediation in math or English and Blacks and Hispanics were 1.5 times as likely. The report did not break out remedial classes by students' socioeconomic status or free and reduced priced meal recipients, but it may be the case that remedial classes are mostly needed by low socioeconomic students and within this group there is an overrepresentation of minority students. In order to glean a snapshot of what happens to New Mexico high school graduates who take remedial classes when attending New Mexico colleges, the report

reviewed a cohort of 8,300 students from 2003-2008. When looking at six years after they started college, they found that 36% of these students obtained a certificate or degree. This suggests that remedial courses to some extent are helping New Mexico high school graduates persist in college and/or complete a degree making them an important course offering to educate local residents. In the Fall of 2009, when looking at the 9,713 New Mexico high school graduates that entered New Mexico colleges, the top three institutions students attended were: 1) New Mexico State University (N=2,664 or 27%), 2) University of New Mexico (N=2,329 or ~24%), and 3) Central New Mexico Community College (N = 2,187 or 22.5%).

University of New Mexico

The University of New Mexico's (UNM) main campus is located in Albuquerque, New Mexico, the state's largest city. UNM is the state's flagship institution of higher education as it falls into the Carnegie Foundation (2011) classification of Doctoral-Granting University (formerly Research I, or Research University – Extensive), which means it is a selective institution that engages in very high research activity (Appendix A). For institutions to achieve this title, they need to grant 20 doctoral degrees annually and participate in extensive research. The mission of the University is:

> To serve as New Mexico's flagship institution of higher learning through demonstrated and growing excellence in teaching, research, patient care, and community service. UNM's ongoing commitment to these cornerstones of purpose serves to:
>
> - Educate and encourage students to develop the values, habits of mind, knowledge, and skills that they need to be enlightened

citizens, contribute to the state and national economies, and lead

satisfying lives.

- Discover and disseminate new knowledge and creative endeavors

    that will enhance the overall well-being of society.

- Deliver health care of the highest quality to all who depend on us

    to keep them healthy or restore them to wellness.

- Actively support social, cultural, and economic development in our

    communities to enhance the quality of life for all New Mexicans.

    (UNM 2010-11 Catalog General Information Section, para. 1)

As the state's public four-year, flagship research institution, it is also known for

its wide range of degree programs (over 218 degrees with 87 baccalaureate degrees) as

well as its size. In 2010, UNM's total enrollment (main campus and branch campuses)

was 36,510 students, making it the state's largest institution of higher education (UNM,

2011). UNM is designated as a minority-serving institution and is one of only four

Research/Doctoral-Extensive institutions in the country to also be designated as

Hispanic-serving as its Hispanic enrollment is well over the criteria of 25%. UNM's

main campus student body by ethnicity includes: 44.2% White [non-Hispanic], 35.5%

Hispanic, 5.6% American Indian, 3.3% Asian/Pacific Islander, 2.9% African American,

3.4% International, 1.4% who reported two or more ethnicities, 0.1% Native Hawaiian,

and 3.7% unknown (students that did not report ethnicity) (UNM, 2011). It should be

noted that the 2010 cohort of beginning freshman was made up of 48.6% Hispanics,

which has progressively increased over the past 5 years and 36.5% White – non Hispanic,

which has progressively decreased over the past 5 years. In 2010, about one third of

UNM students attended part time and two-thirds or ~24,000 students attended full time.

In terms of the gender of students enrolled, in 2010 about 58% of UNM students were

female and 42% were male, matching the national percentages. From 2002 – 2009

UNM's average one-year retention rate (Fall to Fall semester) was about 77%. Over the

past five years UNM's engineering program has seen consistent, small growth in

enrollments with an annual average of 1,084 students declaring engineering as their

major (UNM, 2011).

National Science Foundation Grant

Since the 1970s, the undergraduate student population has transformed from what

we considered traditional college students to a much more diverse population. Over this

time period, the undergraduate population has expanded to include increased numbers of

women, older students, minorities, and students from low-income families. While there

has been an increase in underrepresented minorities attending higher education, the

National Science Foundation (NSF) observed that there was not a corresponding increase

in the number of underrepresented minorities enrolling in or completing degrees in fields

of science, technology, engineering, or mathematics (STEM) (National Science

Foundation, 2009). In the 1990s, the NSF began to fund a consortium of six minority-

serving institutions (Model Institutions for Excellence Program) to help develop

successful strategies for recruiting underrepresented minority students as well as find

methods of supporting their successful completion of STEM degrees. One of the key

findings from this consortium was the importance of helping to bridge the transition from

high school to college for underrepresented minorities who enroll in STEM programs by

offering summer orientation programs (Kee, 2007). Once the students have been

accepted to a STEM program in college, they fund student support services which include: mentoring programs, tutoring, advising, information on financial aid, and structured peer study groups as a means of helping students stay engaged in science and engineering studies.

Since 1994, the University of New Mexico has received additional funding from the NSF to recruit underrepresented minorities and provide them with academic support in STEM degree programs in a similar manner as the Model of Institutions of Excellence. The cornerstone of the support strategy is UNM's STEM Preparation Program (STEM PREP) that aids underrepresented minorities in the transition from high school to college. Follow-up support for students admitted to UNM's STEM PREP includes ongoing faculty/student mentoring, advisement, student support service workshops, and networking to help retain them in STEM studies. UNM, as a Hispanic-serving institution, serves a larger percentage of minority students and with the NSF funding the goal is to help attract these students to STEM programs, support them while in these programs, and increase their representation in science and engineering degree completion.

Statement of the Problem

Many college students enter higher education lacking the cultural capital, advisement, or support necessary to select the most appropriate institution and/or properly navigate complex academic systems within institutions, which can put them at-risk for not persisting or completing a degree. In some cases, underrepresented minority students may also lack the academic preparation to succeed in college level courses when they first enter higher education. While colleges may offer developmental classes to help

22

prepare students academically for college level courses, these classes do not count towards a degree and can greatly extend the students' cost and time to graduation. There is an assumption that students should arrive academically prepared. Is there more that can be taught to help students learn how to navigate complex systems and make decisions that will better prepare them to be successful in school and in life? How can colleges help students in their academic and social development so that they can successfully persist?

Colleges and universities that are aware of the challenges that their students face are more apt to implement interventions designed to help students in their college classes. Since first-year undergraduate students are particularly vulnerable to leaving college because of inadequate academic and social integration (Tinto, 2006), we know that the timing of student success programs is important. Some of the early interventions implemented range from student success classes, first-year seminars, and/or extensive orientation courses. While some research results suggest a positive relationship between participation in student success courses and short-term academic performance (Wells, 2008), it is essential for colleges to better understand how they can best support students in a manner that improves student persistence and college success.

Purpose of the Study

This study focused on making meaning of how underrepresented minority students persist in science, technology, engineering, and math (STEM) programs at an extensive research university in the Southwest. I took an in depth look at how underrepresented minority students, from the STEM Preparation Program, experience their transition to college and learn about the factors to which they attribute their ability

to persist in college. Much of the literature focuses on student departure and it is my goal to examine how the underrepresented minorities in STEM programs at a southwestern research institution experienced college success and persisted. My intention is to provide student voices to the literature as a means of better understanding their successful academic experiences.

By identifying successful, underrepresented minority students and deeply exploring what they do to persist in STEM programs, higher education can gain a better understanding of how to provide academic interventions and support to future students in a manner that will improve graduation rates in science, technology, engineering, and math as well as provide greater educational equality. This qualitative, phenomenological study was conducted to gain the students' points of view relating to their experiences as underrepresented minority students in STEM programs who persisted past their third semester and are successful in college. These particular students were provided with additional academic student support in the summer before they transitioned to college and it is important to learn how the preparation they received helped them to persist. After the summer program, they received additional support in the form of faculty/student mentoring, advising, information on financial aid, as well as workshops relating to college success. Their insight can help to inform existing programs as well as new programs and/or systems designed to better support all students, especially, underrepresented minority students as a means of improving their persistence and STEM degree completion in higher education.

Chapter Two - Literature Review

Introduction

Democratic education aims to empower all citizens to be free, equal, and willing to work collectively to create a just and thriving society. Dewey (1934) declared that the aim of education should be the development of individuals to their utmost potential, enabling them to contribute to the liberation and enrichment of the lives of others. It was his belief that "every individual has an equal right to share in the cultural and material fruits of collective human invention, industry, skill and knowledge" (Dewey, 1934, p. 245). Dewey (1934) advocated that public funded education was the fundamental method of social progress and reform. The American view of post-secondary education is that of a ladder of credentials that provide opportunities that yield upward social mobility and financial returns (Aronowitz, 2000; Grubb, 2002; Grubb & Lazerson, 2005). Under the definition of a true democracy this might be the case, but what transpires within a society of people who compete for what may be perceived as a scarcity of resources may altogether be quite different. Weisberger (2005) posited that community colleges, like all educational institutions in our society, are not neutral. "They are part of the social, political, and economic fabric of our society. As such they are subject to the ongoing class struggle, that has characterized this country since its inception" (Weisberger, 2005, p. 138). By accounting for the sociology of education, there remains the possibility that schools may function as the fundamental method of social reproduction of a class system. When seemingly invisible topics like social reproduction remain unexamined, society can continue to espouse the belief that each individual has

equal opportunity while providing privilege to some of the population, at the expense of others.

Sociological Influences

Bourdieu (1986) used the game of roulette to explain the imaginary beliefs of meritocracy:

Roulette, which holds out the opportunity of winning a lot of money in a short space of time, and therefore of changing one's social status quasi-instantaneously, and in which the winning of the previous spin of the wheel can be staked and lost at every new spin, gives a fairly accurate image of this imaginary universe of perfect competition or perfect equality of opportunity, a world without inertia, without accumulation, without heredity or acquired properties, in which every moment is perfectly independent of the previous one, every soldier has a marshal's baton in his knapsack, and every prize can be attained, instantaneously, by everyone, so that at each moment anyone can become anything. (p. 46)

Included in this imagery of a universe with perfect equality, Bourdieu exposed how the faith in meritocracy leads to the false conclusion that those who fail to gain an education must inherently be inept. This thought process therefore shifts the blame to the individual's lack of ability and takes the responsibility off of society as a whole. Bourdieu (1986) clarified, "the presuppositions inherent both in the commonsense view, which sees academic success or failure as an effect of natural aptitudes…" (p. 47). Rather than acknowledging socially created privileges, this view takes the stance since all

individuals have equal opportunity it is just that some groups of people have higher

aptitudes for academic success than others.

In high schools across the United States, we see evidence of an achievement gap

between economically disadvantaged students and students with higher socioeconomic

privilege. The United States' No Child Left Behind (NCLB) act has the stated goal "To

close the achievement gap with accountability, flexibility, and choice, so that no child is

left behind" (NCLB, 2002, Sec. 1.). In a review of NCLB, Ellis (2007) argued that

NCLB is widening the gap between socioeconomic classes as opposed to its initial

mission to close the achievement gap. Despite the espoused purpose of NCLB,

educational experiences provided to students, based on their socioeconomic background,

remain vastly divergent (C. R. Ellis, 2007; J. B. Ellis, Lamoureux, Awender, Wessel, &

Donohoo, 2008). In lower performing schools, students are predominantly only learning

to take a test rather than having focused time to develop critical thinking and learning

knowledge and skills that can serve them in real world situations. Based on a literature

review, various methods of replicating socioeconomic stratification in education were

identified which include: unregulated school choice, charter school initiatives,

standardized curriculum and testing as a result of No Child Left Behind (NCLB),

subjective guidance counselor recommendations to students, tracking students, and

program differentiation within educational institutions or systems. While low

socioeconomic status students have access to educational programs, the difference is that

existing policies favor the affluent students and the systems seemingly are designed to

better prepare these privileged students from elementary school through college.

Academic preparation coupled with the cultural capital provides affluent students with

the ability to succeed in their higher education endeavors and graduate from elite, selective institutions.

Tinto (2006) identified this gap as a result of a student's low socioeconomic status:

> "…student income, has to do with the critical issue of equity. It can be stated as follows: though access to higher education for low-income students has increased, gaps in access between high-and low-income students decreased. The gap between well-to-do and poor students in four-year degree completion remains. Indeed it appears to have increased somewhat over time." (p. 10-11)

With this obvious gap, we realize our public education system is not equally serving students of low socioeconomic status. While we are providing them access to public schools and community colleges, we are not achieving equal educational outcomes for all students. We do not take into account differences in academic achievement, college readiness, and academic success for economically disadvantaged students. Ignoring this issue allows for society to continue to replicate existing social structures of class in the United States.

How can we explain the difference?

Given that all students have access to public education, how can we explain the issue that about a quarter of our population is academically underprepared to continue on to higher education? Bourdieu (1986), a French sociologist, grappled with this discrepancy in the early 1960s and in doing so developed the concept of "cultural capital" or cultural habits and dispositions, which one traditionally inherits from their family, as a

fundamentally important element of student success. He explained how he formulated
his theory:

> The notion of cultural capital initially presented itself to me, in the course
>
> of research, as a theoretical hypothesis which made it possible to explain
>
> the unequal scholastic achievement of children originating from the
>
> different social classes by relating academic success, i.e., the specific
>
> profits which children from different classes and class fractions can obtain
>
> in the academic market, to the distribution of cultural capital between the
>
> classes and class fractions. (Bourdieu, 1986, p. 47)

Bourdieu (1967) acknowledged the schools' role relating to students' cultural
integration.

> … scholarly or academic culture, is a meaning to the same words, the
>
> same types of behaviour and the same works and, conversely, to express
>
> the same meaningful intention through the same words, the same
>
> behaviour patterns and the same works, it is clear that the school, which is
>
> responsible for handing on that culture, is the fundamental factor in
>
> cultural consensus in as far as it represents the sharing of a common sense
>
> which is the prerequisite for communication. (p. 341)

The culture at a school for predominantly poor children will likely be drastically different
when contrasted with a school where most students are of higher socioeconomic status.
The school, as an institution, plays a role in the reproduction of class.

Cultural and Social Capital

Bourdieu (1986), while trying to make meaning of the inequality of academic achievement, recognized during research that achievement could be explained by differences in cultural capital between social classes. He identified that this was a systemic issue that was located amidst people's cultural habits and behaviors working within institutions. In his conception of cultural capital, Bourdieu moved away from the traditional definition of culture and explained how these shared norms and values could be cultivated by one's family and later leveraged for degree attainment (which defines social position) and translated into an ability to exchange culture for economic capital. He recognized that cultural capital was a resource that was capable of generating profits and tended to be monopolized by individuals and class groups. Bourdieu (1986) outlined three forms of capital and how they are tied to an individual's economic gain:

> Capital can present itself in three fundamental guises: as *economic capital*,
> which is immediately and directly convertible into money and may be
> institutionalized in the forms of property rights; as *cultural capital*, which
> is convertible, on certain conditions, into economic capital and may be
> institutionalized in the forms of educational qualifications; and as *social*
> *capital*, made up of social obligations ('connections'), which is
> convertible, in certain conditions, into economic capital and may be
> institutionalized in the forms of a title of nobility. (p. 47)

Traditionally the latter two, cultural and social capital, are considered to be non-economic. However, Bourdieu characterized cultural and social capital as symbolic forms of human capital that can be exchanged or leveraged for economic capital. In this

view, power, dominance, and privilege can be derived not solely from material resources but likewise from cultural and social resources as long as they remain valued by society. For societies with highly stratified social classes that maintain a formal system of education, Bourdieu (1986) asserted that the advantages of cultural and social capital largely stemmed from the institutions' "criterion of evaluation," for example, their methods and standards of assessment tend to highly favor students of a particular social class who have extensive cultural capital or already know how to be academically successful in school.

In a similar manner, Bowles and Gintis (2002) discussed the concept of reproduction of consciousness, highlighting the two key mechanisms of transmission: family and the educational system. They set forth that there is a direct correspondence with the structure of schools and the workplace and posited that the cognitive skills developed in school are not the primary factor for determining income (Bowles & Gintis, 2002). They affirmed that the structuring of social interaction and reward systems in schools replicate the environment of the workplace. The social consciousness and behavioral traits that a student learns in school set them up for a job in workplace hierarchy. They pointed this out to highlight the non-cognitive effects of education that impacts students' future earnings.

Psychological Influences

Identity

Erikson (1980) worked in the field of social psychology and is well known for his research and theories relating to identity development. He expanded on Freud's five stages of early development and created a model of eight stages that describe the

physical, emotional, and psychological development required for an individual. His

contribution to the field was the addition of three stages, post adolescence, which dealt

with identity development into and throughout adulthood. In *Identity and the Life Cycle*,

Erikson (1980) outlined the eight stages:

> Stage 1: Infant (Trust versus Mistrust – Needs maximum comfort with minimal
>
> > uncertainty to trust themselves, others, and the environment
>
> Stage 2: Toddler (Autonomy versus Shame and Doubt – Works to master physical
>
> > environment while maintaining self esteem
>
> Stage 3: Preschooler (Initiative versus Guilt – Begins to initiate activities,
>
> > develops conscience and sexual identity)
>
> Stage 4: School-aged Child (Industry versus Inferiority – Tries to develop sense
>
> > of self-worth by refining skills)
>
> Stage 5: Adolescent (Identity versus Role Confusion – Tries to integrate many
>
> > roles such as; child, sibling, student, worker into self-image under role
> >
> > model and peer pressure)
>
> Stage 6: Young Adult (Intimacy versus Isolation - learns to make personal
>
> > commitment to another)
>
> Stage 7: Middle-age Adult (Generativity versus Stagnation - seeks satisfaction
>
> > through productivity)
>
> Stage 8: Older Adult (Integrity versus Despair - reviews life accomplishments,
>
> > deals with loss).

According to this theory, if individuals are inhibited from fully developing in one

stage, they may proceed to the next stage, but they likely would be held back by the

remnants of the stage(s) that were underdeveloped. Erikson (1980) believed that in the process of identity development an individual generally would come up against an identity crisis, which would compel them to work towards mastery of each developmental stage. When describing his notion of identity crisis, it is not necessarily a massive crisis as one might imagine, but instead "a crucial moment, when development must move one way or another, marshaling resources of growth, recovery, and further differentiation" (Erickson, 1980, p. 26).

Within his identity development theory, Erickson placed a great importance on looking at external influences, which could be geographical, historical, and/or cultural yet played a role in shaping the individual's identity. Erikson spent a part of his life interacting closely with the Lakota and Sioux Indians. Based on his observations of the Sioux Indians, he described extreme differences of geographic and historical perspectives, which influenced their identity and how it would meet a crisis in the new world. He illustrated this by comparing the past Sioux identity of the buffalo hunter and juxtaposed it with the occupational and class identity of the American civil service employee, who was tasked to re-educate the Sioux. Erikson stated, "Therapeutic as well as reformist efforts verify the sad truth that in any system based on suppression, exclusion, and exploitation, the suppressed, excluded, and exploited unconsciously accept the evil image they are made to represent by those who are dominant" (1980, p. 59).

Ibarra (2001) asserted that much of the research on ethnicity in higher education oversimplifies and aggregates data, sometimes making it useless for learning about people of different cultures in higher education. He points out that despite steady increases of underrepresented populations in higher education, especially women, equity

and diversity remains elusive on university campuses (Ibarra, 2001). Early in his career

he conducted research among an isolated community of Norwegian immigrants in

Westby, Wisconsin. While immersed in the community, he recognized the Norwegians

had developed several ethnic identities, including: "immigrant Norwegian," "rural,

American," and "commercialized Norwegian" (p. 37). He found that all of these

identities were well accepted cultural adaptations and were displayed by most members

in the community. Drawing from his research experience of Norwegians (2001), he has

suggested that Latinos, likewise, carry multiple identities and are required to use them to

identify with a range of cultural constituents within our society. Ibarra (2001) stated,

"cultural blending is one adaptive strategy for accommodating multiple ethnic identities

(e.g. Mexican, American, or Mexican American) that many ethnic populations exhibit in

this country today" (p. 39). While Ibarra acknowledges multiple and concurrent ethnic

identities as part of his construct, he pointed out that individuals and institutions of

education may impose a fixed ethnic identity onto minority students. Ibarra recognized

the conflict between the culture and ethnicity imprinted onto individuals in childhood by

family and community, and the cultural forces that they encounter in the system

throughout their education. Ibarra (2001) borrowed from Fredrik Barth's assertions for

analyzing culture in complex societies and created his own guidelines for studying Latino

culture:

> 1) Cultural meaning is linked to an individual's particular experience,
>   knowledge, and orientation in society,
>
> 2) Culture is distributed in a population; it is shared by some but not by all
>   others,

3) A person's life experiences and interactive patterns between groups

govern that person's position in society,

4) Cultural events are the result of interplays between the material world

and social interaction and thus are always in conflict with the intentions

of individuals (p. 31-32).

Ibarra utilized his previous research on culture and the multiple identities of

Norwegian immigrants and worked towards reframing the context of higher education in

a manner that would better serve Latino students in higher education, specifically

working towards increasing representation in graduate programs.

Motivation Theory

Maslow's (1943) theory of motivation was based on what he outlined as a

Hierarchy of Needs, which consists of stages of individual human growth and

development. This hierarchy of needs is commonly illustrated in a pyramid format since

the base needs are considered foundational, meaning you must satisfy the lower levels of

needs first in order to continue towards developing higher level needs. From the base of

the pyramid to the top, the needs are (Maslow, 1943, pp. 18-22): 1) Physiological (food,

water, sleep), 2) Safety (shelter, security, stability), 3) Belonging (intimacy, togetherness,

acceptance by a group), 4) Esteem (perception of self-worth, mastery, recognition), and

5) Self-actualization (achieving individual potential, self-fulfillment). With this

hierarchy, Maslow (1943) theorized that if all human needs are unsatisfied then the

individual is dominated by her/his physiological needs, rendering all other needs as

nonexistent and unconsidered. Hence, this individual will not have the ability for growth

or development. Maslow outlined that in the same manner and potency that deprivation

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affects the individual, so, too, does gratification as an individual strives to develop and

move on to higher levels of the pyramid. Maslow's hierarchy of needs can be useful in

helping to understand some of an individual's psychological barriers to growth that are

likely to inhibit academic success. If a college student's basic physiological and safety

needs are not met, it is implausible to assume they can continue personal development

towards self-actualization.

An Individual's Psychology and Student Success in STEM

Erikson's stages of identity and Maslow's theory of motivation combine to

illustrate the complexities inherent in human development. The bi-cognitive

development work by Ramírez and Castañeda (1974) combined with the rich diversity in

cultural identity presented by Ibarra provide insight into experiences that students from

the non-dominant ethnicity encounter within the education system. Each individual has

her or his own cognitive domain, affective domain, and unique cultural identities that

form from birth through adulthood. Each individual student may encounter cultural

identities imprinted or assigned to them by other individuals or educational institutions as

well. Bourdieu's (1986) sociological lens illustrates how an individual's identity can be

greatly influenced by collective class identities socially constructed by groups of citizens.

An individual's psychology in relation to identity and motivation becomes important to

take into account for underrepresented minority students who plan to pursue STEM fields

of study. Each student arrives in college with differing levels of motivation and

individual identities that have been influenced by their experiences, class, family, and

society. Students whose families are from lower social classes, do not necessarily have

interactions with professionals who work in STEM careers. They may simply not have

the cultural capital that would have exposed them to professional STEM fields, and therefore many not include STEM in their options related to career selection. Underrepresented minority students would have to make a conscious effort to choose a field of study that falls outside of the norm for the members of their family and community.
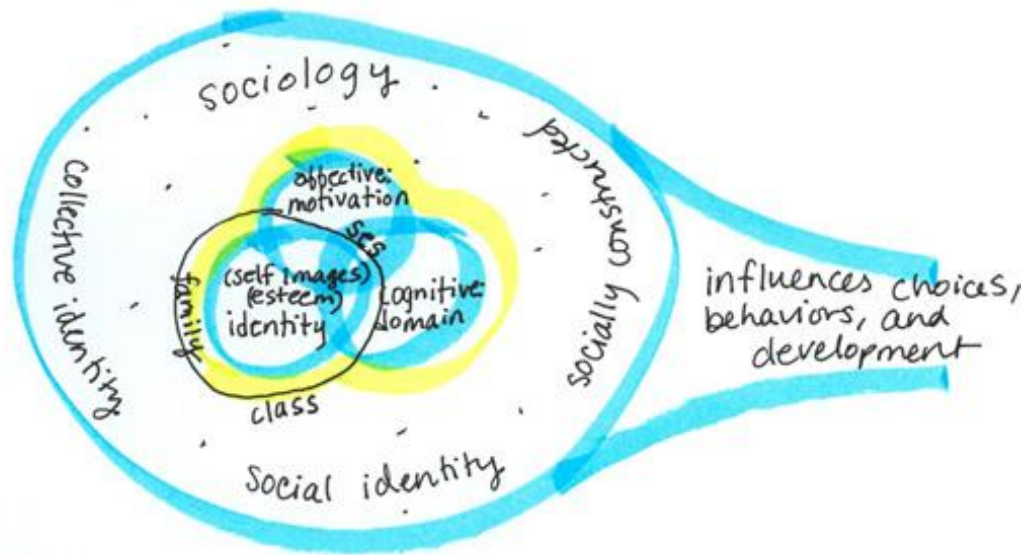
Figure 1. Individual Psychology with Social Influences on Identity

The diagram in Figure 1 illustrates how an individual's psychology can be influenced by multiple cultural contexts, such as family, economic class, societal views of the individual and in turn this drives the formation of an individual's choices, behaviors, and future identity development. Taking this into account may increase the importance of acknowledging developing an individual's ability to be self-aware, increasing their cultural capital, and continued development of identity into adulthood, as a means of helping them to be successful in college. For example, if a student from a lower social class encompasses the identity of "bad student" based on years of negative feedback throughout secondary education, it may require the individual to acknowledge

what influenced their identity while working to transform their identity into "capable

student." Students often consider pursuing the careers their parents have. For a white,

male student who has a parent in a STEM career it may be quite natural to consider

pursuing a STEM field of study. However, for a student from a lower social class with

little exposure to professionals in STEM careers, it becomes a situation in which they

must determine if they believe that they could encompass the identity of a professional in

a STEM field of study. In essence, they must adjust their identity and gather the personal

motivation that will allow them to pursue a STEM career that has not been presented to

them as within the "norm". In addition, given that their ethnicity within the STEM

workforce is underrepresented it would be rare that they might meet a mentor who was a

STEM professional and of the same ethnicity. Often for underrepresented minorities, it is

important to see people who they consider to be just like them working successfully in

the workforce in order for them to consider approaching the same career. When students

do not encounter people within their family, community, or peer network who are STEM

professionals, it is less likely that they may consider, on their own, to pursue a STEM

field of study in college.

Overview of Student Persistence

Public colleges and universities enroll about 70% of all undergraduate college

students including students who may be of low socioeconomic status, first generation, or

minority students who are frequently underprepared academically (Engstrom & Tinto,

2008; Weisberger, 2005). Over the past five years there has been an increasing trend in

growing enrollments, yet graduation or completion rates remained unchanged (Snyder,

2011). About 28% of first time students at four-year institutions are enrolled in at least

one remedial course (American Association of Community Colleges, 2006). Students who were not academically prepared during secondary education are less likely to readily succeed and complete a college degree (Aronson, 2008; Bastedo, 2003; Dowd & Melguizo, 2008; Laird, Chen, & Kuh, 2008). With growing budget cuts, along with increased educational accountability, remedial and developmental programs are being reviewed to ensure they are not a duplication of effort (or the same education that one should have received in high school) and to determine if they are preparing students to succeed in and be retained in college level courses. It is important to understand if remedial math and English can help underrepresented minority students better transition from high school to college and persist in college STEM programs.

Student persistence, or a student's likelihood of remaining enrolled until they obtain a credential or degree, is of concern to educators and policy makers because large numbers of students begin college but do not graduate (NCES, 2003). Currently, a large portion of minorities attends two-year higher education institutions where graduation rates are low (Bailey, Calcagno, Jenkins, Leinbach, & Kienzl, 2006). The national community college three-year graduation rate for first-time students in 2000 was 29% (Horn & Neville, 2006). The findings from the study, *Profile of Undergraduates in U.S. Postsecondary Education Institutions: 2003-04: With a Special Analysis of Community College Students* (Horn & Neville, 2006), indicated that a substantial percentage of students enrolled in formal degree programs did not necessarily intend to complete a degree. This study, however, did not explain why this was the case. While the community college movement has extended access to college for many traditionally underrepresented students, it has not yielded a large proportion of graduates from this

group nor has it transferred large proportions of students on to four-year institutions. In 2008 1.5 million bachelor's degrees were awarded. When looking at bachelor's degrees held by adults between the ages of 25-29 compared to subgroup populations in the United States, there remains variation based on ethnicity (Aud, 2010). The percentage of bachelor's degrees held by ethnicity for 25-29 year olds, from highest to lowest: Asians (60%), Whites (33%), Blacks (17%), Hispanics (11%), and Native Americans (8%) (Aud, 2010). In this same year, a higher percentage of total degrees earned by Hispanics and American Indian/Alaska Natives were two-year associate degrees (Aud, 2010). It is clear that the quality of learning, persistence, transfer rates, and bachelor degree completion for minorities needs to improve in higher education.

Student Attributes

College success can be understood as a student's ability to persist towards the goal of completing a college degree. Moving away from the "blame the victim" mentality, the research related to college persistence is beginning to unveil student characteristics, via sociological and psychological lenses, as well as institutional characteristics that lead to college success. Pascarella and Terenzini (1991) reported that colleges with a higher proportion of full-time students serving students who had higher SAT scores and were from higher income families had higher rates of graduation. Since the 1991 study, extensive research has shown that characteristics of students most likely to graduate include students who have: strong high school preparation, entered immediately after high school, a family with a high income, parents who attended college, and the ability to attend college full-time and uninterrupted (Allen, Robbins, & Sawyer, 2010; Braxton, 2000; Braxton, Hirsch, & McClendon, 2004; Burns, 2010; Eaton

& Bean, 1995; Kim, Newton, Downey, & Benton, 2010; E. T. Pascarella & Terenzini, 1991; Tinto, 2006). Tinto (1993) asserted that students arrive at college with a set of traits (for example; ethnicity, secondary school achievement, parental encouragement for college, and family socioeconomic status), that influences their initial level of commitment to the institution as well as their goal of graduation.

Bowles, Gintis, and Meyer (1999) asserted that students are socialized at home and in school, fostering personality traits through reward systems. Their research demonstrated a strong independent association between family background and economic success. Their argument is that the parents' job experiences tended to be reflected in the social relations of family life. Hence, parents' orientations toward work, their aspirations, and self-concepts are shared with their children in a manner that prepares them for a similar station in life (Bowles et al., 1999). They believe it is these personality traits, as opposed to performance (grades in school or work performance), that impact a person's success and pay in the workplace. They make direct correlations between a teacher's evaluation related to behavior in the classroom and a supervisor's rating for behavior on the job. In this manner, parental economic status is passed on to children through personality traits that are learned and home and reinforced at school.

Socioeconomic Status

Social class stratification within educational institutions can hold students with low socioeconomic status back and continually reproduce the socially constructed class structures within the United States. Anyon (1995) suggested that public schools in complex industrial societies, like that of the United States, make different types of educational experiences available to different social classes; for example, providing

vocational education to low socioeconomic students and reserving highly competitive

selective academic university admissions for society's most affluent students. When

examining policies that differentiated academic programs and/or students by level,

researchers found that, instead of reducing class barriers, the policies contributed to and

reproduced stratification, widening the gap between the economically advantaged and

disadvantaged (Aronson, 2008; Bastedo, 2003; C. R. Ellis, 2007; J. B. Ellis et al., 2008).

Bowles, Gintis, and Meyer (2002) showed that parental economic status was passed on to

children through unequal access to educational opportunity, meaning lower

socioeconomic students attended different schools than higher socioeconomic students.

They asserted that it was not the cognitive skills gained at school that were the primary

factor, rather, it was the socialization process of the schools that prepared students for

their future role in the workplace. They believed there is a tendency for families to

reproduce a consciousness in their offspring tailored to their work experiences, which

prepares them for economic positions comparable to their own; and in turn the education

system reinforces the socialization process within schools.

Analyses of national cohorts demonstrated that students with higher

socioeconomic status experience higher rates of transfer from two-year to four-year

institutions and higher four-year completion rates (Dowd & Melguizo, 2008). Coming

from a higher socioeconomic status can provide students with the luxury of attending full

time as well as a financial and cultural capital safety net. Scholars attribute the higher

rates of transfer to affluent students with economic resources, who also have better

academic preparation, and note that they are likely to do well and survive in a variety of

institutions (Calcagno, Bailey, Jenkins, Kienzl, & Leinbach, 2008). Aronson (2008)

declared that future research should examine the impact of social class on the experience of attending different types of institutions.

Gender

When comparing students enrolled at a four-year institution with students enrolled at a two-year college, community college students were more likely to be older, female, from a low-income family, and also less likely to be White (Finn, 2006).   Over the past two decades, women have enrolled in undergraduate education and attained college degrees at a higher rate than men. During the years 1980–2001, women represented the majority of undergraduate students increasing respectively from 52% to 56% (Peter & Horn, 2005). In addition, women also made up a majority of the students awarded associate and bachelor degrees during this same time period. While women have increased their overall representation in college enrollments and completion of degrees over time, they remain underrepresented in engineering and other STEM fields.

Intersection of Ethnicity and Socioeconomic Status

When looking at student persistence rates in STEM fields by ethnicity Anderson and Kim (2006) found that Hispanic and African-American students had persistence rates below the average overall persistence for their respective racial/ethnic group. In addition, the graduation rates of African American and Hispanic students in STEM fields lagged behind those of white and Asian students (Anderson & Kim, 2006). In examining the role of socioeconomic status and race in students' track mobility, Bergersun (2009) found that students of color were more likely to move to lower tracks than whites. Banerji (2006) found that class was a bigger factor than race when it came to counseling high

school students. In other words, counselors were more likely to suggest students pursue a four-year college education based more on their affluence as opposed to their race.

Within the system of education, there remain disadvantages for being a student of color as well as low socioeconomic status. Keeping this in mind, it may currently be more important to pursue socioeconomic diversification, but it would seem there is an intersection of class and race that should be acknowledged. This review of research highlights how systems of education fail to adequately serve low socioeconomic status students as well as minority students through all of the stages of education, resulting in an overall lower participation and success in higher education. While many low socioeconomic students fall into the category of students of color, it is important to note that not all students of color are from a low socioeconomic status. When colleges are designing programs to support students in persistence and degree completion, they need to consider a students': socioeconomic class, culture, high school preparation, and parental level of education.

Academic Preparation

A strong foundation in academic courses or academic preparedness is necessary for students to be successful in college. Conley (2008) asserted that students who are well prepared for college were engaged in building key cognitive strategies throughout their elementary and secondary education. The key cognitive strategies he outlined are those that enable students to learn across disciplines, including problem solving, inquiry, reasoning, interpretation, along with precision and accuracy (Conley, 2008). All of these cognitive strategies represent the higher levels of Bloom's Taxonomy (for example, synthesis and evaluation). Students who complete high level mathematics courses (for

example, trigonometry, pre-calculus, calculus) are more than twice as likely to graduate from college as compared to their peers who only complete basic mathematics-algebra (Adelman, 2006; Conley, 2008). In addition to cognitive strategies and key content areas (for example, math), Conley (2008) posited the need for developing individuals' self-management skills or in other words a student's ability to think about how one is thinking. The meta-cognitive processes that he identified that were needed for academic success are self-awareness, self-monitoring, and self-control. Both student learning and personal development must be addressed to provide opportunity with a reasonable expectation of college success (Grimes & David, 1999). As outlined by Conley, "… the student who is ready for college will be able to understand the culture and structure of postsecondary education and the ways of knowing and intellectual norms of this academic and social environment" (2008, p. 4). In short, these variables that predict college success are measures of high cultural capital that a student has acquired throughout their life. Their academic preparation, coupled with cultural and social capital, serve them well in college and have proven to be highly correlated with degree attainment in higher education.

First generation Students

First generation students are college students whose parents do not hold a degree in higher education (neither an Associate's degree nor a Bachelor's degree). Although first generation students are overrepresented in for-profit institutions, half of all first generation students enroll in community colleges as their first institution. Of this population, these first generation students are overrepresented in certificate programs, meaning they plan to complete college without a two-year degree. The higher the level of

parents' education, the less likely it is that a student will be in a certificate program and the more likely it is the student will be in an associate degree program and or transfer program to a four-year institution (Chen, 2005). This is important to note since parents with higher education levels are able to advise their children towards degrees in four-year institutions based on their experiences. Colleges and universities need to be aware that first generation students are likely to need more support through academic advisement, student support services, and faculty engagement.

Theoretical Models of Attrition

Many researchers in higher education have studied student attrition in attempts to understand why a large percentage of students who attend college do not attain a degree. Tinto (1993) identified five theoretical perspectives: psychological, economic, societal, organizational, and interactional. Tinto's model has been extensively empirically tested and applied most frequently in research at many four-year institutions across the nation. Tinto's well known interactional model (1993) of student retention outlines a framework that students who are enrolled in an institution will most likely remain and persist if they become integrated into an institution along two dimensions, academic and social. Academic integration is defined as a student who is integrated into the intellectual life of a college, meaning students who are engaged in academic discourse and activities with their faculty and peers. Tinto (1993) outlined social integration as being comprised of a student's network of relationships with others outside of the classroom. He postulated that the greater the level of a student's social integration the more likely the student's commitment to the institution would increase, preventing student departure.

Subsequent studies that were conducted using Tinto's model looked at gaining an understanding of student departure with commuter college students or students who did not live on campus. "The basic elements of the theory of student departure from commuter colleges and universities include student entry characteristics, the environment within and external to campus, and the student's academic integration on campus" (Seidman, 2005, p. 74). Braxton, Hirsch, and McClendon (2004) created a diagram to illustrate their theory of departure for commuter college students (see Figure 2).
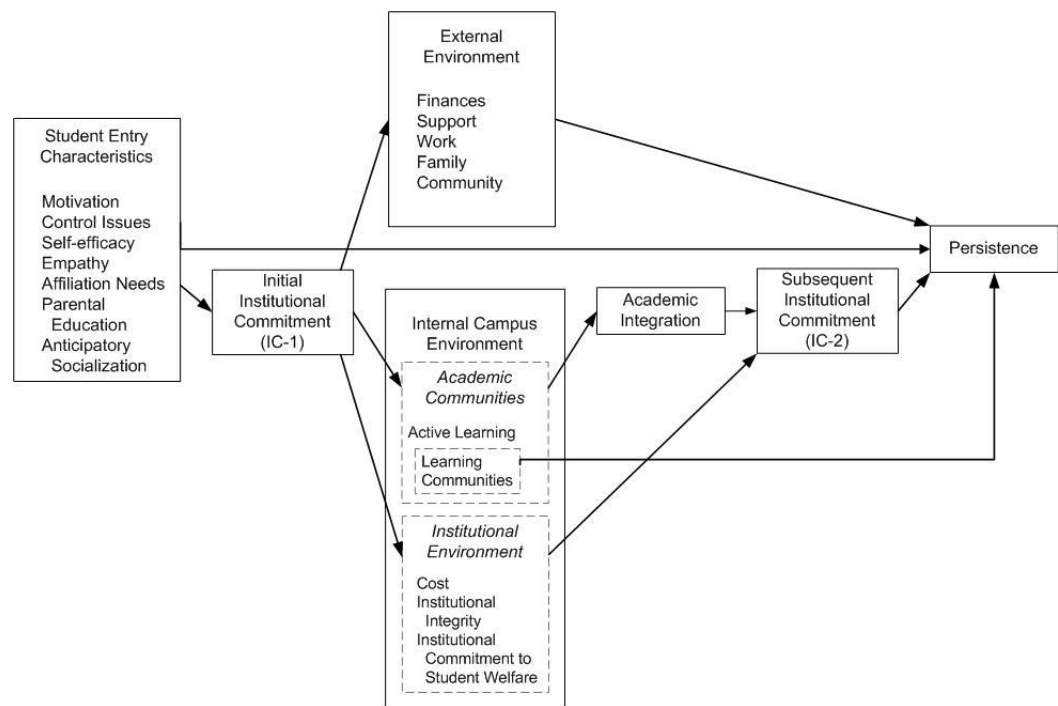
Figure 2. Theory of Student Departure in Commuter Colleges and Universities

This model illustrates the factors that lead to student persistence with the understanding that when these factors are not present, the result will likely mean the individual will depart from the institution. The diagram begins with students' entry characteristics since these can have a strong influence on an individual's ability to persist in college. Braxton, Hirsch, and McClendon (2004) illustrated that students with

motivation and self-efficacy tend to persist in their goals in college and in turn they

develop an initial commitment to the institution, which engages them in the process. The

model then shows that both the campus environment and the students' external

environment play a significant role in the ability for an individual to feel academically

integrated, which leads to increased commitment to the institution ultimately improving

persistence.

> Deil-Amen (2011) also recognized the shortcomings of this dichotomy:
>
> … such a conceptual distinction between the "academic" and the "social"
>
> creates a false dichotomy that obscures the nature of the fused socio-
>
> academic encounters that dominate the integration experiences of two-year
>
> college students and their subjective understanding of the student-
>
> institution interaction. The concept of a "socio-academic integrative
>
> moments" can be used to describe opportunities for specific instances of
>
> interaction in which components of social and academic integration are
>
> simultaneously combined. (p. 72)

With a change in student characteristics (low income, commuting, less academically

prepared), it is prudent to be aware of previous beliefs and forge new means of

application.

Building on Tinto's model, Eaton and Bean (1995) developed an

Approach/Avoidance Model that is designed to take into consideration psychological

constructs to determine if they contribute to student attrition. Eaton and Bean (1995)

asserted, "students who take active approaches to learning and social situations in college

are better integrated academically and socially" (p. 638). Their examination of

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behavioral components (1995) in the student attrition model helped to demonstrate that background characteristics, for example, demographic information, are not the only type of predictors that can help to identify students who are likely to persist in college. "Students bring different combinations of approach and/or avoidance behavioral strategies with them to college that are a reflection of behaviors learned in other similar environments" (Eaton & Bean, 1995, p. 639). Eaton and Bean (1995) did make a distinction between academic (formal involvement) and social (informal involvement) as a means of integration. In situations where students were involved in formal involvement and leadership, there were positive effects on academic integration. They also found in multiple cases that college students could feel socially integrated while simultaneously being maladapted academically. In these situations, their social involvement functioned as a means of avoiding their academic challenges. Therefore, it is important to discern between formal and informal involvement when working towards academic integration that leads to student success. They concluded that these behavior strategies could provide clues about an individual's attitude or intentions relating to his/her ability to successfully adapt within the college environment (Eaton & Bean, 1995). Calcagno, Bailey, Jenkins, Kienzl, and Leinback (2008) determined that individual student characteristics appear to be more important determinants of graduation and retention than institutional characteristics; nonetheless, a review of institutional characteristics may provide some useful insight for individual community colleges.

Institutional Characteristics

As a means of helping administrators, educators, and researchers assess institutional performance, Calcagno et al. (2008) conducted research to measure the effect of institutional characteristics on graduation rates. They developed a model to adjust simple graduation rates for the following institutional characteristics: student composition, expenditures, size, and location. The approach they used was appropriated from a common practice used at four-year institutions and they applied it to a sample of 915 two-year, community colleges. The Calcagno et al. (2008) study showed a consistent negative relationship between enrollment size and completion meaning as the enrollment increased, degree completion at the institution decreased. Other negative relationships occurred with colleges that had a high percentage of minority students, part-time students, and women. Calcagno et al. (2008) recognized the limitations of their review of this large dataset and stated that their model could be used "… as a research tool to identify samples for further study using qualitative methods" (p. 644). This quantitative study identified an issue, but an institution would need to complete qualitative research to better understand why larger enrollments have a negative impact on graduation rates.

Five hundred and forty-six U.S. bachelor degree granting institutions participated in the National Survey of Student Engagement, administering more than 285,000 surveys to college students across the nation in order to gain a better understanding of student engagement. A key finding was that institutions that had students who participated in high impact practices (Kuh, 2011) experienced positive effects related to student success and retention. These high impact practices connected the practice of deep integrative

learning or providing relevant opportunities for students to apply knowledge.

(Engagement, 2010; NSSE, 2012). Institutions across the nation are looking at methods

in which campuses can create supportive learning environments as a means of increasing

student engagement and retention. However, not all student success interventions offered

have proven to be as effective as high impact practices. An overview of the types of

interventions that four-year institutions typically offer is provided.

Types of Interventions to Support Student Success

While it is certainly important for us to "understand why students leave" when

considering institution action, it is quite another to "know what institutions can do to help

students stay and succeed" (Tinto, 2006, p. 6). With privilege based on one's familial

socioeconomic status, it becomes very important that institutions recognize some of these

systemic social issues and develop the ability to proactively identify students who possess

factors that place them at risk for dropping out, so they can provide effective

interventions that enable persistence and academic success before it is too late. If

colleges intend to address the issue of class and its attendant privileges (or lack thereof)

when taking up educational reform, they will need to "move beyond an emphasis on

individual motivation to focus on institutional and social change" (Aronson, 2008, p. 51).

In short, colleges need better diagnostic abilities to determine the needs of

incoming students relating to remediation and support for individuals as a means of better

preparing them for college success (Adelman, 2006; Conley, 2008; Engstrom & Tinto,

2008). Both student academic learning and personal development must be addressed to

provide opportunity with a reasonable expectation of college success (Conley, 2008;

Grimes & David, 1999; Yazedjian, Toews, Sevin, & Purswell, 2008). When confronted

with challenges in education, it is not uncommon that institutions take an approach to create interventions that try to alleviate those challenges. Sometimes these interventions are designed as separate entities and may not be properly integrated into the core curriculum. A review of the types of interventions can give insight into whether or not they address academic learning, personal development, and are integrated into the curriculum for optimal student success.

First Year Experience

Involvement, or what has come to be referred to as engagement, matters most during the critical first year of college (Tinto, 2006). As a result of this research finding, many four-year institutions have developed and delivered seminars or orientations that are called "First Year Experience" as a means of helping freshman college students to integrate into the institution. These seminars commonly include study skills, time management, campus resources, academic planning, career exploration, critical thinking, college policies, relationship issues, diversity issues, and writing skills (Duggan & Williams, 2011). These seminars were first introduced in the early 1970s and have proliferated on campuses across the nation. Since then, there have been many studies related to the effectiveness of first year experience seminars. For the most part, the studies indicate that they produce positive, statistically significant results relating to student persistence at four-year institutions. However, Pascarella and Terenzini (2005) found first year experience seminars to show minimum positive, indirect effects on grades, academic integration, retention, and completion. Generally these interventions are not integrated into the curriculum and function as a stand-alone seminar. Since implementation of first-year experience interventions vary widely from college to

college, it is difficult to group them together and come to a single conclusion about effectiveness.

College Success Courses

Many colleges have begun to offer "college success" classes a means of helping underprepared students learn strategies to be successful in their academic classes. Typically, these classes are one to three credit classes designed to provide information on effective, task-related study skills together with personal development skills relating to self-management of learning and self-motivation. Karp (2008) found that students learned most of their college-related knowledge, for example, types of student support services, in a student success course. His study also identified that if the college success class was not required for all students, it inadvertently created inequitable access to support services. The students who were not required to attend a student success class, they found, lacked the knowledge of the type of student support services that were available to them or how to elicit support. While these courses focus on academic skills and college preparation, some do include an aspect of personal development and developing meta-cognitive abilities. These courses generally are separate and not integrated with college content.

Classroom Practices / Active Classroom Environment

When a student arrives at college, he/she is interpreting the environment and constantly appraising whether or not they want to establish membership in the academic and social communities (Tinto, 1996). If their appraisal is that they do not feel they fit in at the college, over time they may choose to depart. Today's college students are more diverse than those in higher education in decades past, with the majority of students

commuting to campus and working part-time while pursuing their degree (Laird, Chen, &

Kuh, 2008). In most cases for these commuter students, their only opportunity for

academic integration is within the classroom, as it becomes the sole venue in which they

regularly have face-to-face contact with faculty and other students.

Campuses with higher than expected persistence offered classes with higher levels

of student engagement developed by faculty who provided academic challenge, active

learning, as well as effective teaching strategies (Kee, 2007; Laird et al., 2008). The

combination of collaborative learning and student-faculty engagement was associated

with student success. Faculty can create methods of developing peer networks through

interactive classroom activities, peer review, as well as encouraging study groups as a

means of helping students to develop academic integration. Faculty who utilize a

coaching or mentoring approach with students can also aid in developing the students

ability to navigate the complexities of an educational institution.

For many decades, there has been a belief that support groups such as student

services were responsible for helping students persist in college. With recent research

relating to college persistence suggesting that student engagement is a promising area for

colleges to emphasize, perhaps it is time to shift away from the focus on student support

outside of the classroom and further understand how classroom practices can better

develop student engagement. For commuting college students (those that do not reside

on campus), the classroom functions as the only venue in which they regularly have face-

to-face interaction with faculty, other students, and staff. College campuses that had

higher-than-expected rates of student persistence also had higher levels of student

engagement integrated into their entry-level college courses (Laird, Chen, & Kuh, 2008),

where in-classroom interactions were the dominant mechanism of socio-academic

integration (Deil-Amen, 2011). The classroom strategies that generated student

engagement were active and collaborative learning, emphasizing effective study

practices, and student work that created academic challenge and required higher-order

thinking skills as outlined in Bloom's Taxonomy, for example, analysis, synthesis, and

evaluation. It may, therefore, become quite important to understand what faculty can do

to structure their courses to instill active learning, student engagement, and socio-

academic integration.

Active learning is a teaching strategy that moves away from excessive lecture and

passive forms of learning and creates student engagement and responsibility in the

learning process. Some examples of active learning include small group work, writing

for synthesis, student-led activities, student presentations, and peer review. Active and

collaborative learning practices are especially important to first year college students

because they help to create a link between the institution's academic and social systems

(Deil-Amen, 2011; Laird et al., 2008; Tinto, 2006). In order to improve persistence,

institutions should focus on the nature of early academic experiences in all classes as a

means of enhancing student engagement as opposed to offering a separate first-year

experience seminar. There are two key components of student engagement (Laird, Chen,

& Kuh, 2008):

> The first is the amount of time and effort put into their studies and other
>
> activities and experiences associated with the outcomes that constitute
>
> student success. The second is how the institution allocates resources and

organizes learning opportunities and services to induce students to

participate in and benefit from such activities. (p. 87)

Their suggestion is that colleges integrate good teaching practices that generate

student engagement and support within the classrooms of all lower division courses as a

means of developing all students during the critical first year. The classroom then

becomes an important venue that integrates learning content knowledge while creating

student engagement in the learning process, as well as develop faculty and peer support

for students.

High Impact Practices

The National Survey of Student Engagement (NSSE) committee reviewed high

impact practices that students engaged in and found that there was a correlation between

actively participating in these activities and student retention. The type of activities that

were considered high impact practices included: learning communities, service-learning,

research with a faculty member, study abroad, internships, and culminating senior

experiences (Kuh, 2011). Student who actively engaged in high impact practices were

more likely to have meaningful interactions with faculty and peers, spend a lot of time

and effort learning outside of the classroom, and were provided with frequent and

meaningful feedback (NSSE, 2012, p. 21). When looking at graduation rates by

ethnicity one four-year NSSE institution reported that when students of color participated

in high impact practices it increased their likelihood of graduating (Kuh, 2011).

Although these high impact activities were beneficial for minorities, when looking across

all institutions at senior-year students who participated in high impact practices, there

were disparities. NSSE (2012) found that there were lower participation rates for first

generation students, minority students, transfer students, part-time students, and older students (non-traditional age). It is not only important that institutions make these opportunities available to all students, but it is important that they are aware who is participating in them. By advising underserved students to engage in high impact activities, institutions encourage academic integration and provide support for the students otherwise may not persist.

Building Social Capital through Socio-Academic Integrative Moments

Bourdieu (1986) defined social capital as the set, durable, deliberate relationships that make up one's social networks, which entitles them to collectively-owned capital: "The volume of the social capital possessed by a given agent thus depends on the size of the network of connections he can effectively mobilize and on the volume of the capital (economic, cultural, or symbolic) possessed in his own right by each of the those to whom he is connected" (p. 51). Therefore, it is understood that there is great advantage to be born into a class that affords you the privilege of access to cultural capital and extensive social networks. This serves to help an individual be successful within the education system. It is important to ensure that first generation students learn how to develop a network of support from peers, faculty, staff, and other organizations to help them persist in college. Building relationships with faculty, counselors, advisors, or other students can provide first generation students with the social capital to strengthen academic knowledge and lend encouragement and needed information about cognitive, behavioral, and procedural strategies for success in class, college, and career (Deil-Amen, 2011). First generation and two-year college students are otherwise not likely to have ready access to this information through their family, peer or social networks. Contact

with faculty provides support, enhances a sense of belonging, and helps develop cultural capital for marginalized students.

Theory of Action

There has been a fair amount of research published on the topic of college success. Traditionally, indicators such as high school grade point average (GPA), achievement tests, parental education levels, and socioeconomic status have been looked at as predictors of college success. As an adjunct instructor at a community college and a research university, I have met students with factors that can negatively impact their persistence; however, they had developed resilience which allowed them to create their own strategies to persist in college. Despite the identity others had placed on them, they reformed their personal identity and developed cultural capital, with the support of others at the institution, and successfully persisted. It is integral for students who may possess factors that inhibit their persistence in college, for example first generation and underrepresented minority students, to have consistent support while developing their cultural capital. For students in a STEM program, their mentor should understand the STEM curriculum and challenges. Therefore, it becomes important for STEM undergraduates to leverage faculty/student mentoring as a means to persisting and completing their degree.

Taking into consideration the ideas that "students' engagement in school – their choices, struggles, and negotiations - is clearly affected by, and in turn influences, who they think they are, who they think they want to be, and who they actually become" (Kaplan & Flum, 2009, p. 76), I believe that it is important for institutions of higher education to determine what they can do to support students' identity development while

in college. If a student possesses a negative self-identity (incapable of doing math, not college material, etc.) that may have been placed on them through social transmission, this will likely compromise their natural desire to learn or willingness to create and seek new knowledge. Where a student attends high school may greatly affect his/her mathematics ability and study skills upon entering college. I believe that there is an overall pattern to learning mathematics and once one learns the overall structure and logic, along with spending the necessary time on homework, college students can master the subject. In some cases, students may just need to address a math deficiency and/or relate the math to relevant real world problems to gain an understanding of what they are solving for. Students who possess factors that may impede their college success, I believe, have to work on building personal academic strategies while simultaneously working on their identity development, recognizing and leveraging their strengths, and developing their ability to articulate who they are and who they wish to become. It is important for them to develop their cultural capital and become engaged with faculty and peers in high impact practices, which helps them to apply their learning, persist, and continue to develop access to future career opportunities.

Research Question

Disproportionate numbers of students who drop out of higher education institutions are members of historically underserved groups (Laird, Chen, & Kuh, (2008). Persistence and educational attainment rates must improve if postsecondary education is to meet the needs of our nation (Braxton et al., 2004; Laird et al., 2008; Seidman, 2005; Snyder, 2011; Tinto, 1996). This suggests that we need methods of improving the graduation rates of underrepresented minority students in addition to our traditional

students who persist. By examining modern systems of education as institutions that may validate and augment cultural capital that students have learned from their families and communities, we can better understand how society and its institutions replicate social status. While higher education may not be currently serving all students equally, it is important to identify what can be done to create college success for historically underserved students as a means of improving higher education for our society. Colleges need to identify ways of improving academic success by helping students develop academic skills, social and cultural capital, as well as supporting individual development. To address a gap in the literature that has reported quantitative data on student attrition and departure, I conducted a qualitative, phenomenological study of students from a mid-sized research university in a southwestern state to gain a better understanding of the viewpoints and experiences of underrepresented, minority students who persist in science, technology, engineering, or math programs. My research was guided by the following question: *How do underrepresented minority students enrolled in a university's science, technology, engineering, or math program experience college success and persist towards degree completion?*

Chapter Three - Research Methods

Introduction

The purpose of this research was to gain a better understanding of how underrepresented minorities develop their academic abilities to persist in college. By conducting a phenomenological study I explored the perspectives and experiences of how underrepresented minorities experienced their transition from high school and how they developed the skills and abilities to be successful in college. The following question guided my research: *How do underrepresented minority students enrolled in a university's science, technology, engineering, or math program experience college success and persist towards degree completion?*

Purpose of the Study

This study sought to make meaning of underrepresented minority student persistence in science, technology, engineering, or math (STEM) programs at the University of New Mexico. The university offered a four-week STEM preparation program to help underrepresented minority students transition from high school while learning content and study skills to help them succeed in college. Throughout the study I refer to this program by the pseudonym, STEM PREP. I explored how underrepresented minority students who had completed STEM PREP experienced their transition from high school to college. In the process, I learned about their secondary school preparation and how they perceived the National Science Foundation grant-funded STEM PREP curriculum helped to prepare them for college level courses. I discovered the factors to which they attribute their college success. Finally, I strove to provide the students' voice to the large amount of literature relating to student persistence.

By identifying underrepresented minority students who persist in STEM programs and deeply exploring and learning what they do to achieve college success, institutions can gain a better understanding of how to provide support and interventions to future students in a manner that will increase graduation rates in STEM fields and support greater educational equality. This study was a qualitative, phenomenological study conducted to examine the students' experiences with the intent to inform existing programs as well as new program and/or system development that will better support underrepresented minority students in persisting in STEM programs and achieving bachelor's degrees.

Research Design

The aim of social constructivism is to understand aspects of human activity from the perspective of those who experience it (Creswell, 2009). Using the qualitative research approach, I utilized an inductive process of discovery when interviewing participants in order to experience and understand what meaning they make of their educational experience in college. The intent of my research was to study how college students who are underrepresented ethnic minority students perceive their educational transition to college and their persistence in a STEM program of study.

In qualitative research, the procedures and methodology are inductive, emerging, and/or shaped by the researcher's experience in collecting and analyzing data (Creswell, 2007). The researcher becomes the instrument to collect observations, perspectives, and stories for review and analysis. A primary goal for the qualitative researcher is to work towards articulating the voices of others in a manner that illuminates their perspectives and tells their story, which is referred to as being emic in nature. Qualitative inquiry is

generated from fieldwork and emerges from the researcher's observations and interviews out in the real world (Creswell, 2007; Patton, 2002).

Phenomenology

Phenomenology, a human science methodology, describes the meaning for several individuals of their experience of a phenomenon (Creswell, 2007). Phenomenology is used to learn how people experience phenomena. For example: what is it like to be a student failing math? Or, how do people feel about their math skills? The methodology is used to gain a deeper understanding of how people experience a phenomenon and its effect on them. To understand the original definition of phenomenology, it is helpful to understand the term, *Geisteswissenschaften*. *Geist*, which is roughly translated to mean human, carries a much broader meaning in German. The native meaning includes all that makes one human, the experience of the human life and how the individual interprets the world around him and communicates to others through language, art, medicine, law, etc. (Van Manen, 1990). *Wissenschaft*, which has been translated as "science," also carries a nuanced meaning in German. Rather than narrowly being used to describe physical science and empiricism, it is broadly interpreted in German to include art and the humanities (Van Manen, 1990). Phenomenology is a methodological framework within *Geisteswissenschaften* that is used to study human experience with the world around her or him and how she or he interprets certain things or phenomena (Van Manen, 1990).

The purpose of phenomenological research is "to borrow interesting framing… to borrow other people's experiences and their reflections on their experiences in order to better be able to come to an understanding of the deeper meaning or significance of an

aspect of human experience, in the context of the whole human experience" (Van Manen, 1990, p. 47). With this research study, I sought to gain insight into the phenomenon: How do underrepresented minority college students enrolled in science, technology, engineering, or math programs experience college success? How do they make meaning of their ability to succeed in college level classes? From a socioeconomic frame, how do they perceive their engagement within the institution? What do they perceive as factors that contribute to their ability to succeed in their college level classes?

STEM Preparation Transition Program

Since 1994 this southwestern university has offered a grant-funded STEM preparation program (which will be referred to using the pseudonym of STEM PREP) for underrepresented minority students who plan to pursue a degree in science, technology, engineering, or math. STEM PREP was funded by the National Science Foundation (NSF) to help underrepresented minority students, who are interested in STEM programs at the university, to transition from high school to college with the purpose of recruiting students and helping to improve student persistence in STEM. The NSF defines underrepresented minorities as: Hispanic, African American, Native American/Native Alaskan, and Native Hawaiian/Pacific Islander. It also includes female students as an underrepresented gender in STEM fields. STEM PREP is a four-week, tuition-free curriculum that is delivered to an average of 22 underrepresented minority STEM students each summer prior to their first semester in college.

STEM PREP provides underrepresented minority students with an immersive experience in college classes (they receive college credit) during the summer semester as a means of preparing them for college expectations. A primary goal of STEM PREP is to

enhance college preparation as a means of improving student persistence and success in a rigorous STEM program. STEM PREP was designed to assist in acclimating to the academic expectations in college for math, English, and computer technology to support students in their transition to college and position them to succeed in a STEM program. The summer math course includes the fundamentals of algebra, geometry, trigonometry, and calculus to prepare them for advanced college level math classes. Homework assignments and quizzes are given and students are provided a math tutor in the evenings. At the end of the four-week session, they are provided with the opportunity to take the COMPASS math placement test. A student's score on this math placement test determines their entry level math course. In general, STEM students are striving to place into college level calculus. This is particularly important because success in mathematics courses is a key to persisting in STEM degree programs (Gilmer, 2007). Adelman (2006) reported that students who succeed in challenging math courses in high school (algebra II and above) experience higher graduation rates in high school. The academic intensity of a student's high school curriculum counts more than other pre-college experience in providing momentum toward completing a bachelor's degree (Adelman, 2006).

During STEM PREP students lived on campus, in the dormitories, and became acquainted with how college works while they attended classes. They gained a feel for faculty expectations and college lifestyle, as well as learned about student support services, which included tutoring, counseling, and academic advising. While on campus they were issued their student identification cards, email account, registered for courses, and designed their program of study. This all took place during the summer, a time when the campus environment is less busy and lines are shorter. In addition, once in STEM

PREP, students received ongoing student success workshops relating to study skills, time management skills, and financial aid during their critical first-year of college. All STEM PREP students had access to the program's faculty coordinator as well as a cohort of peers to collaborate with to help them navigate the complex systems of the university.

Methodology

The research philosophy for this study was grounded in constructivism. The aim of constructivism is to understand aspects of human activity from the perspective of those who experience it (Denizen & Lincoln, 2005). The intent of my research was to study the phenomenon of how underrepresented minority students experience college success and develop strategies to persist in STEM programs. I used an inductive process to explore the many truths held by the participants related to their educational experiences. The focus of this research study is to look at the phenomenology of how underrepresented minority students at a southwestern university perceive their educational experiences, their persistence, and college success in a STEM program of study at a research university.

Methods of Data Collection

This research study explored how underrepresented minority students make meaning and assign value to their educational experiences while they successfully persist at a research institution in a STEM program. I utilized three methods of data collection in this study: interviewing, observing, and reviewing documents. The data collection included the following methods: 1) STEM PREP faculty interviews, 2) STEM PREP student interviews [2 per participant], 3) observation of a study group of STEM students,

and 4) document review. This study was conducted under the approval of the University

of New Mexico's Institutional Review Board (Appendix B).

Here is an outline of the sequence of events related to data collection:

1. Recruitment – program coordinator sent out a recruitment flyer (Appendix C) that

   I designed to solicit the participation of eligible STEM PREP students and STEM

   PREP faculty. Flyers were posted on public bulletin boards in the engineering

   library, engineering buildings, and math and science buildings.

2. Volunteer participants contacted me to schedule initial interview.

3. I scheduled initial interview with volunteer participants and determined if:

   a. Meeting needed to occur in person (on campus in a study room in the

      library) based on if student was in state and able to meet locally.

   b. Meeting needed to occur via Skype (online Voice Over Internet Protocol -

      VOIP), based on if the participant was currently out of state and needed to

      meet virtually.

   Note: all interviews occurred in person, unless the participant was out of state

4. Conducted initial student interview (Appendix D). At the completion of the

   interview, I scheduled the second, one-hour interview within two weeks of the

   first interview. Students were asked to reflect on their educational experiences

   and jot down notes, or thoughts they had in the interim. They were also invited to

   bring an artifact related to their educational experiences, that they would like to

   share at the second interview.

5. I typed up and reviewed the first interview transcripts prior to the follow up

   interview. I took notes related to follow-up questions for the participant.

6. Second student interview was conducted. Students were asked questions from the second interview (Appendix E) along with custom follow up questions.

7. I typed up the second interview transcripts.

8. I conducted periodic review of completed interview notes and transcripts.

9. I continuously reviewed the list of participants interviewed to review demographics and ensure a balance of ethnicity, gender, percentage of college completion.

10. Completed student interviews with 10 students (20 interviews).

Interviews were conducted with STEM PREP Faculty members as well as with student participants. STEM PREP faculty interviews (Appendix F) were conducted with three faculty members and the STEM PREP program coordinator to gain their insight into the STEM PREP and its students. Interviews with faculty were semi-structured and I explored how they experienced the STEM PREP, what they believed the program did to help students, and how effective it was at bridging the transition from high school to college for underrepresented minority students who plan to pursue a STEM field. I asked the faculty questions to gain an understanding of their observations of the STEM PREP students during the years they taught in the program. In the interest of continuous improvement, I also requested ideas they had about what they observed that did not work well and could be a potential area of improvement. They were asked to share ideas and solutions for improving the overall program.

Student interviews (two per participant) were conducted to gather information about the participants' transition to college experiences, attitudes, beliefs they have around their personal persistence, perceptions, and cultural beliefs as well as how they

felt they fit at the research university. In addition, I sought to understand how they perceived STEM PREP had helped to support them in their academic goals. After each initial interview, I transcribed the interview and review notes prior to the second, follow-up interview. This allowed me to determine if I had additional questions that I needed to ask for clarification of a topic or probing questions to better understand a situation the participant described.

I used my literature review to guide the creation of interview questions and the type of information I plan to gather in the interviews. I learned from participants what factors they feel help or hinder their success in college. I explored how students perceive their fit within the structure or culture of the research institution. It was my intention to provide a student voice to how college does or does not serve them, as well as learn what they perceive as the most significant barriers to attaining their educational goals. The interviews helped me learn how a student's culture aligned or conflicted with the institutional culture as well as learn how they mitigated any conflicts or barriers. The shared experiences of the participants were used to develop a rich narrative that will help to inform future educational programs and/or policies created to reduce social stratification within higher education. This data will be valuable in informing the design of policy that will promote more equitable distribution of knowledge and degrees (Grimes & David, 1999). In this process, I strived to understand how the participants' culture, identity, or socioeconomic status had impacted their success in higher education. I also explored how they perceived STEM PREP had helped them prepare for their field of study. It was important to learn which aspects of the program they found most

beneficial and to gain insight into the ideas they had about what would help them to continue to be successful in their effort towards degree completion.

Originally, it was planned that I would observe a STEM PREP meeting led by the program coordinator and attended by STEM PREP students. Due to a reduction in funding, the STEM PREP program did not run during the summer of 2012, making it impossible to observe a STEM PREP meeting. However, during data collection and interviewing process, it emerged that an important aspect of socio-academic integration and college success for all of the participants related to forming and participating in study groups. Based on the emphasis that students placed on these study groups, I decided that in lieu of observing a STEM PREP meeting, I would observe a STEM study group session. The purpose was to observe how students interacted during a study session with their peers, to gain a sense of how they helped each other out with homework, and to observe the learning process outside of the classroom. Study groups were generally formed by students who were either taking the same course or who had the same major. They were informally created by the students themselves, not the institution.

STEM PREP documents were reviewed including the student application form, STEM PREP program schedules, and a STEM PREP student success report written by the program coordinator to learn about any pertinent program information. The purpose of document review was to gain an understanding of the processes used to implement the program, the application process, the content of STEM PREP, and student support provided. In addition, during the interviewing process, I conducted a memoing process. I kept a journal throughout the research process to document my thoughts and experiences. I have reviewed these notes and considered them in the analysis process.

Participants

Participants in this study were underrepresented ethnic minority students (as defined by the NSF) and/or female (white females are defined as an underrepresented gender by NSF) who enrolled in a STEM program and participated in the STEM PREP at the university. STEM PREP was funded by the NSF between the years 1994-2011. Students who persisted into their third semester of college or beyond their freshman year, a year that yields high drop rates, were invited to participate in my study. On average, an annual cohort of 22 students was accepted to and participated in the STEM PREP.

Students that completed the STEM PREP in the years 2006 through 2010 and who persisted at a minimum into their third semester in a STEM degree program of study were invited to participate via a recruitment flyer that was distributed by the STEM PREP program coordinator. I selected ten students who participated in two face-to-face interviews. The goal was to find participants of both genders and a range of ethnic minorities who are underrepresented in STEM programs. As a means of gaining a broader perspective, I included participants from a range of STEM PREP cohorts (sophomores – graduates) who were at various years of persistence. In the event that more than eight students volunteered to participate, I planned to conduct a selection process to ensure that I maintained a variety of students represented in the interviewing process. For example: if there were fewer male students with the eight students, I would review the future volunteers and give priority to male students as a means of balancing the overall representation. The priorities for selection were as follows: 1) ethnicity (to ensure students who are most underrepresented in STEM programs at this university are selected as well as including a mix of ethnic minorities), 2) gender (to ensure the voices

71

of both female and male students are captured), and 3) years of college completed by the

student (to ensure I have included the voices of students who persisted at various

percentage rates of completion, ranging from third semester to graduated). When I

reached the eight student participants, I reviewed the list of student volunteers. At this

point, the selection process was utilized and I selected the final two students by ethnicity.

Two Native American volunteers could not be interviewed until the next semester, based

on their personal schedules. I selected these two Native American students to ensure the

voices of students from their ethnicity were represented in my study.

Data Collection

Tobin and Begley (2004) pointed out that the use of a number of different

methods, approaches, and points of view helps to obtain a more complete picture of a

complex and diffuse phenomenon. I utilized three methods of data collection in this

study: 1) interviews, 2) observation, and 3) document review. See Figure 3 for an

overview of the timeline of this study.

Timeline of Data Collection for the Study			
Document Review (FSBP Website)	Interviews (1st)	Interviews (2nd)	
Document Review (NSF Website)	Transcribe Interview #1 and Review Interview notes	Transcribe Interview #2 and Review Interview notes	
	Researcher Journal	Researcher Journal	
	Student Reflect on Educational Experiences (jot down notes, find artifact)	Observation (Student Study Group Meeting)	Document Review (Transcriptions, Student Reflections, Observation Notes, Researcher Journal)

Figure 3. Timeline of Data Collection for the Study

Two interviews were scheduled with each student participant. For each interview the date, location, interviewer, and interviewee were documented. The interviews were semi-structured, meaning I asked open-ended questions to begin the interviewing process with participants and allow for free flow of their answers. The open-ended questions were designed to allow the participants' stories to emerge, "open up topics, and allow respondents to construct answers in ways they find meaningful" (Riessman, 2008, pp. 24-25). These open-ended questions (Appendix D & E) helped to ensure that they had the opportunity to share stories relating to their previous educational experiences in secondary education, socioeconomic status, individual barriers, mentors, cultural identity, and cultural capital. I took notes during the interviews and gained permission to record the interviews in order to develop full transcripts from the recordings. By conducting two interviews with each student participant, it allowed them to reflect on the topic after the first interview and before we met for the follow-up interview. After the first interview, I asked participants to reflect on the stories they just shared and to take or jot down notes on any ideas they had related to the topic in between interviews. I asked participants to bring to the follow-up interview any notes and/or artifacts that they felt were important or that helped to tell their story around college success. Between interviews, I reviewed notes that I had taken and used an inductive process to guide the questions that I planned to ask and/or the focus of the next interview. The transcripts of each interview were later coded for data analysis as a means of determining themes that emerged from the participants' responses.

An observation of one STEM study group was conducted during the semester in a public study area. As recommended by Creswell (2009), qualitative researchers collect

data in the field where participants experience the issue of focus of the study. This allows the researcher to experience the participants interacting with their peers while they learn new content, work on homework or projects, and possibly study for an exam. The results may prove useful as a means of seeing the participants' behaviors related to how they interact with their course content and their peers, which may otherwise be difficult for the participant to articulate as they may be unaware of tacit behaviors.

The researcher maintained a journal throughout the research process. During the qualitative research process, the researcher maintains a focus of learning the meaning that the participant makes of the issue or problem (Creswell, 2009). By reviewing what participants shared in their first interview, allowing them to process and reflect, and then return with potential artifacts that help to tell their story, I was able to focus on what meaning they make of their success and persistence.

Researcher as the Instrument

I remained an outsider to the study as I completed a major in liberal arts. While I took advanced mathematics and chemistry in college, I was never enrolled in a STEM program of study. When I examined my secondary education experiences, I clearly identified times when I was tracked into vocational education programs (for example: cosmetology classes in seventh and eighth grade) and held back in Mathematics based on my gender, minority status, and/or perceived socioeconomic status, but not based on my grade point average or standardized math test scores. While I excelled in mathematics and science, completing calculus and physics in high school, I was never encouraged to pursue studies in science or engineering. After having worked closely with engineers at Intel Corporation for a decade, I realized that engineering would have been a field in

which I would have thrived. I realize now that I had the potential to complete a STEM program based on my math and science abilities along with my desire to understand how things work in our world. Yet, there was no one at the time to recruit me to a STEM program and I believe this had to do with my gender. The most egregious experience I had in high school occurred in my junior year when I had to attend a mandatory guidance counselor meeting. My guidance counselor, who only knew me from my folder of information, proceeded to ask me about my plans after high school. I shared with her a list of my top three colleges/universities that I already applied to and hoped to attend. She confidently told me that I had no business applying to those schools and that I needed to consider community college because I was not "college material." I asked her if she had pulled the wrong folder, since I was in the top of my class. I realized quickly that it did not matter what I said, she was not changing her message so I left her office and never returned. Fortunately, I was accepted to eight universities and was academically prepared to obtain my bachelor's degree in four years.

I attribute my strong personal independence to my persistence in the face of socially created barriers. In addition, I attribute my cultural capital to what I learned from my family, which was enhanced by the high socioeconomic status community that I lived in during my high school years. With each barrier I experienced, while I found myself distraught, I refused to let others' views of me reshape my identity and/or hold me back. Instead, these unfortunate events seemingly helped me to become more resilient with each encounter. However, these encounters have made me sensitive towards others who experience tracking in school, students who are firmly told that they are not "college material," and those who may fall outside of the dominant culture of our society. For I

know that even though I resisted the negative stereotype placed upon me, some of it stuck, leaving me with a partial identity formed by others. While I am Asian American, this is not considered an underrepresented minority group in STEM fields as this group has strong representation in STEM degree completion. My worldview and personal research philosophy have been shaped by my life experiences (as well as how I am received/perceived within the American culture) as an American woman of European and Asian descent. The lenses through which I view the world include those of constructivism and critical theory. My belief is that everyone deserves access to quality education and, by helping our traditionally underserved students to develop into life-long learners, we will ultimately help them achieve academic and economic success in their lives while enriching our society. It seems especially important to me that we as a nation develop a diverse population of scientists and engineers as a means of striving for innovation. I hope that my research will contribute to the empowerment of an underrepresented group of minority students.

As a former art student/artist, I have learned to view objects and situations from multiple vantage points. Having participated regularly in the art critique process in which peers and other artists openly share their viewpoints about your work, I am comfortable with my interpretation as well as listening to others to understand what meaning they make of an object. I believe this exposure to critique will be transferable to the research process. While I may have a theory of action related to this phenomenon, it was more important that I was open to listen to the meaning that the participants shared and represent their voices. I share this self-paradigm to help ensure the authenticity of my research project. As pointed out by Lincoln and Guba (2000), qualitative researchers

need to consider the effect of our own beliefs, modes of knowing, contextual interpretations, subjective biases, and inquiry interests to fully understand a particular phenomenon we study.

Data Analysis

The value of qualitative research lies in the particular description and themes developed in context (Creswell, 2009). I employed several strategies to ensure validity of data analysis as a means of allowing the themes to emerge from the data collected from the field within the context of the participants' experiences. Creswell (2007) used the image of a zigzag to illustrate this process of going into the field to begin collecting data, returning to the office to begin analysis of emerging categories, and then repeating the process until reaching saturation. In this manner, the data collection and data analysis processes were occurring simultaneously while I, the researcher, continually reflected on the data, posed analytical questions relating to the data, and documented the process.

I employed a constant comparative method of data analysis, which consisted of a process of taking information from data collection and comparing it to emerging categories (Creswell, 2009). All recordings were transcribed and all transcripts reviewed systematically to identify themes that emerged. I was immersed in the data by listening to all of the recordings, reading and re-reading all of the transcripts, and coding the data to prepare for data analysis. During this process, I took notes on my general thoughts about the overall meaning and ideas of the participants. During the process of data coding, I employed the technique of "memoing" (Creswell, 2007, p. 151) or writing down my ideas and thoughts about the evolving findings throughout the process data collection.

The themes identified were organized and reviewed using matrix analysis. A matrix with key data for each of the 10 students allowed for systematic review of data for all students at a glance. Refer to Appendix G to view a sample portion of a matrix used to help analyze student interview data. In addition, I utilized diagramming techniques to flow chart, group, visually display data, and graph important information. This process allowed me to further examine and analyze the data while making important connections and interconnections.

Coding

Data from interviews were transcribed and coded by hand. While immersed in the data, I analyzed the themes, patterns, and relationships that emerged (Patton, 2002). I utilized "open coding" (Strauss & Corbin, 1998). In the process of open coding I identified and named conceptual categories in which the phenomenon of college persistence was described or observed. Codes were devised to create categories that grouped common concepts. Words, phrases, and events that appeared to be similar were grouped into the same category. These categories were then grouped into a code family (Glaser & Strauss, 2006). My goal was to create descriptive, multi-dimensional categories or a framework for my analysis (Table 1). See Appendix F for an example of a coded transcript.

Table 1

Coding Utilized (Families & Codes)

Code Family	Codes (Conceptual categories)	
Family	• Culture	• Socioeconomic status (low)
	• Parental education (Mother)	• Financial support
	• Parental education (Father)	• Parental perceptions of STEM
	• Single parent	• Sibling education
	• Parental academic expectations	• Cultural capital
	• Family illness	• Family tragedy
	• Family disruptions	

Code Family	Codes (Conceptual categories)	
Student	• Math identity	• Perceptions of discrimination
	• Self esteem	• Cultural awareness
	• Personal factor of persistence	• Language preference
	• Gender	• Cultural capital
	• Responsibility	• Transition to adulthood
	• Resilience	• Societal identity
	• Belief in self	• Old self identity
	• Time management	• Employment
	• Academic planning	• Future orientation
Mentoring	• Mentor / Advocate for STEM	• K-12 teacher mentor
	• Role model	• Parent mentor
	• Faculty mentor	• Peer support
Social Integration	• STEM PREP	• Barriers
	• Peers / Friends	• Student organizations
	• Peer pressure	• Support Network
Academic Integration	• Faculty interactions	• Research opportunities
	• Study groups	• Student organizations
	• Homework	• Leadership opportunities
	• Tutoring	• STEM PREP
College Preparation	• K-12 education experience	• Academic expectations
	• Math (under-preparation)	• High school GPA
	• Math (preparation)	• Math placement for college
	• Preparation by high school	• STEM Support Programs
College Experience	• Advisement	• Scholarship (other)
	• Advisement (lack of)	• Barriers
	• Transition HS to college	• Finances
	• 1st college math class	• Expected graduation
	• Alignment to institutional values	• Faculty from same ethnicity
	• Student enrollment (FT / PT)	• Peers same ethnicity (Lack of)
	• Lottery scholarship	• Summer classes
Career	• Career selection	• Career preparation
	• Additional education for career	• Internships
	• Career goals	• Job search

A final step in data analysis involved meaning making and interpretation

(Creswell, 2009). I interpreted the meaning of the data, captured the essence of the study,

and compared the findings to determine if they confirm or diverge from the current

literature or theories. I utilized member checking by taking my transcripts and high-level

themes that emerged, and had the participants review them for accuracy.

<center>**Standards of Quality**</center>

Validity

Qualitative validity can be achieved when the researcher checks for accuracy of the findings by employing certain procedures (Creswell, 2007, 2009). As a means of checking for accuracy of my findings I: 1) had repeat contact with participants, 2) triangulated data from multiple sources, 3) utilized member checking, 4) strived for thick and rich description, and, 5) allowed for the research process to evolve.

The purpose of repeated contact in the field with participants was to provide a means of developing an in-depth understanding of the phenomenon. As such, I met twice with each participant and provided space and time for them to reflect on the first interview. I employed triangulation or examined evidence from multiple sources (interviews, observation, and participant reflections) and used it to build a coherent justification for themes. I strived to provide thick, rich description of the phenomenon to be studied as a means of conveying the findings based on the data and themes that emerged from the research. Throughout this research study, I was open to the evolving process.

Rigor and Credibility

Reflexivity is an integral part of the audit process, in which inquirers maintain a self-critical account of the research process (Creswell, 2007; Tobin & Begley, 2004). In this manner, I achieved reflexivity by "memoing" (Creswell, 2007, p. 151) thoughts I had about the evolving narrative throughout the process of data collection, in a research journal, and wrote my own reflections in a manner that questioned my personal

assumptions. These two means of reflexivity helped in my efforts to ensure

confirmability and dependability for this study.

Arminio and Hultgren (2002, p. 450) recommended six elements in an

interpretive study to demonstrate "goodness": 1) foundation (epistemology and theory),

2) approach (methodology), 3) collection of data (method), 4) representation of voice

(participants as multicultural subjects), 5) the art of making meaning (interpretation and

presentation), and 6) implication for professional practice (recommendations). With this

in mind, my intent was to make meaning of the data collected and represent the voices of

the participants in a manner that incorporated and wove "goodness" throughout the study.

The overarching goal of this qualitative study was to develop a rich narrative that

provides a space for students' voices about their educational experiences and how they

gain access to college and maintain academic success.

Summary

The pervasive and deeply rooted nature of class differences means that education

reform needs to move beyond an emphasis on individual motivation to a focus on

institutional and social change (Aronson, 2008, p. 51). By providing orientation

programs, transition support, academic and social support for underrepresented minorities

we can improve retention and degree completion in STEM fields (Fenske, Porter, &

DuBrock, 2000; Kee, 2007; Slovacek et al., 2011) and create a more diverse workforce in

science and engineering fields. Aronson (2008) posited that it is important to work

explicitly with low socioeconomic status students that may also be minorities as a means

of helping develop their cultural capital in a manner that helps them navigate and

successfully persist through a four-year degree program, which ultimately impacts their lifetime earnings.

Education policy should be judged by the degree to which it benefits, or at a minimum, does no additional harm to the least advantaged students (Cobb & Glass, 2009). Systems and policies must be analyzed to determine if they create inadvertent barriers to serving underrepresented populations of students and modified to create more integrated STEM programs which consist of a balance of traditional and minority students who are learning together. Diverse peer environments expose students to new social networks and forms of cultural capital that can expand opportunities for success in school, college, and the labor market (Cobb & Glass, 2009). However, for underrepresented students to benefit from peer effects, social classes must be mixed within the same colleges and classrooms rather than segregated based on wealth (Cobb & Glass, 2009; Dowd & Melguizo, 2008; Looney, 2006). Students from all socioeconomic strata, races, and cultures must be integrated. In order to gain the value of diversity in the science and engineering workforce, it is important to identify and improve educational systems and policies that work towards preparing underrepresented minority students for STEM programs, support them through their college career, and guiding them towards graduate studies.

Chapter Four - Findings

Participant Demographics

In this study, interviews were conducted with 4 STEM PREP faculty members and 10 student participants. The faculty interviewed had taught with STEM PREP for at least two or more summers. The 10 students interviewed were underrepresented minority participants who had completed the STEM PREP program and had persisted in a STEM field of study beyond their first year of college ranging from their beginning of sophomore year of college to degree completion. Students were asked to share the number of program credits they had accrued and it was compared to the total number of credits required for their discipline to better understand their current standing in relation to degree completion. Figure 4 illustrates individual degree progress for all ten participants. Of the ten participants, one student had graduated with an engineering degree (represented in green) and was enrolled in a PhD engineering program in another state.
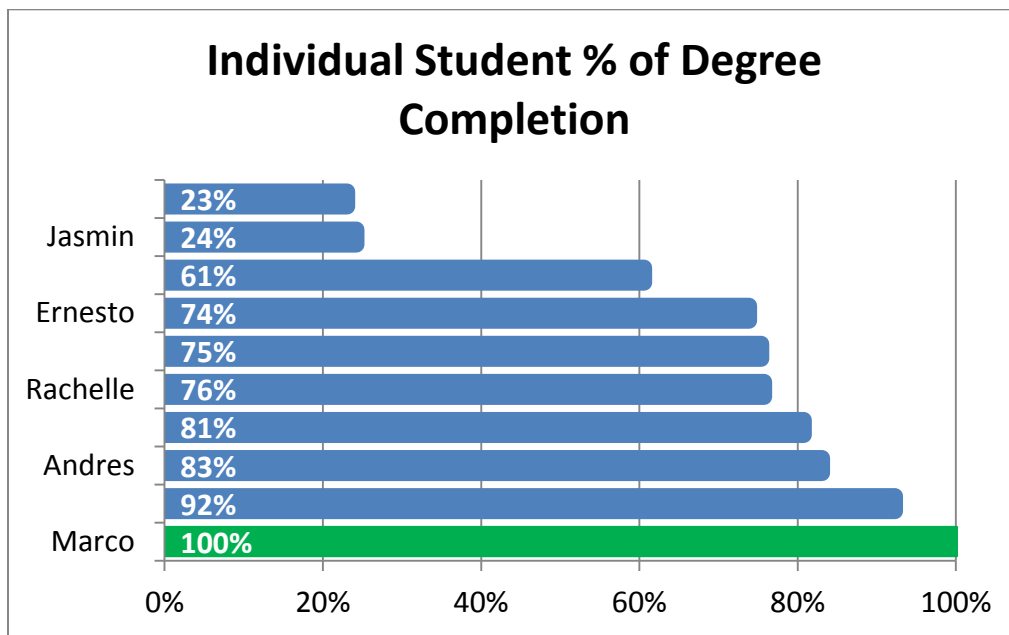
Figure 4. Participants' Percentage Completion of STEM Undergraduate Degree

The number of years that students were enrolled in college ranged from one to five years, with one student estimating that it would take her seven years to complete her chemical engineering degree. Coincidentally, all of the participants were enrolled in the university's College of Engineering with the following disciplines: chemical engineering (5), civil engineering (3), electrical engineering (1), and computer engineering (1). See Figure 5.
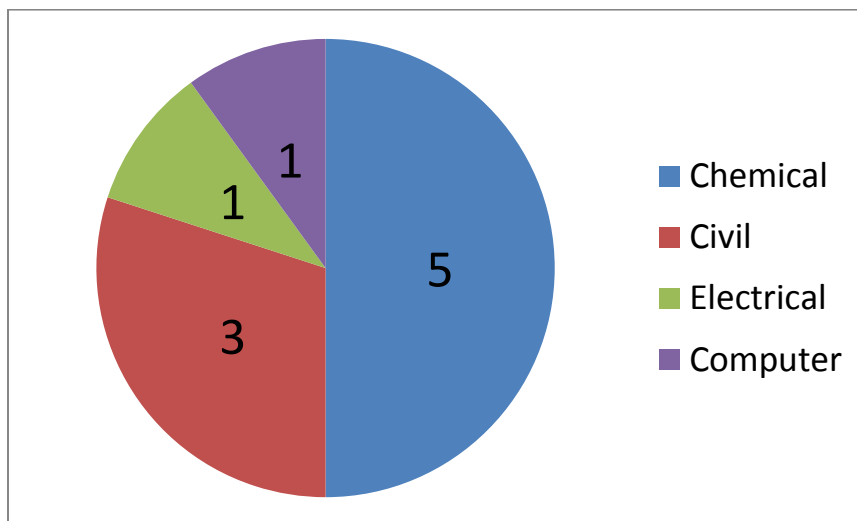
Figure 5. Participants by Declared Engineering Degrees

My initial goal to interview a range of students in regards to ethnicity, gender, as well as students with varying lengths of persistence in a STEM program was met. The ethnicities of participants included: Hispanic (50%), Native American (20%), Mexican (10%), African American, (10%), and White (10%). I should note that one white student qualified for the STEM PREP based on the underrepresentation of female students enrolled in STEM programs. Over the past two decades, women have come to represent the majority of undergraduates students, with 56% enrollment (Peter & Horn, 2005). While female students are overrepresented in college enrollments they remain underrepresented in STEM fields of study, particularly within engineering. Keeping this

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in mind, I wanted to have a balance of both male and female students in the study to ensure I captured experiences of both genders. Fifty percent of the participants in this study were female students and 50% were male students.

Additional demographics collected related to students' first generation status, socioeconomic status, and whether or not they had attended a rural or urban high school. These three factors were interrelated and overall impacted participants' academic preparation for college. The students' socioeconomic status or class was self-reported and ranged from lower class to upper middle class. The split was even with 50% of the students reporting to be lower SES and 50% reporting to be from families of middle class incomes or above. Fifty percent of the students reported that they were academically underprepared and cited this based on not participating in a rigorous math curriculum at their high school. Some did not have access to advanced math classes and others felt they had participated in subpar math classes. Their experiences related to math were shared and I collected information on their first math class taken in college based on either their ACT score or the COMPASS placement exam that they completed as a part of the STEM PREP program. Table 2 outlines the overall student demographics.

Table 2

Participant Demographics (N=10)

Category	Gender (n)	Ethnicity	First Gen.	Urban / Rural	Low SES	High School GPA
	Male (5)	Hispanic (5)	Yes (6)	Urban (6)	Yes (5)	Mean: 3.5
	Female (5)	Native Am (2)	No (4)	Rural (4)	No (5)	Range: 1.5 – 4.2
		African Am. (1)				
		Mexican (1)				
		White (1)				

Table 3 presents each participant using a pseudonym, together with her/his academic outcomes.

Table 3

Participants' Academic Outcomes (N=10)

Participant	Ethnicity	First College Math Class	Degree Program	# of Credits	Attendance Status
Manuel	Hispanic	Calculus I	Elec. Eng.	102/132	Attending FT
Victoria	Hispanic	Trigonometry	Civil Eng.	120/130	Attending FT
Andres	Hispanic	Pre-Algebra	Civil Eng.	108/132	Attending FT
Carlos	Hispanic	Algebra II	Chem. Eng.	76/132	Attending FT
Ernesto	Hispanic	Calculus I	Comp. Eng.	96/130	Attending FT
Mari	Native Amer.	Calculus II	Civil Eng.	30/130	Attending FT
Jasmine	Native Amer.	Algebra II	Chem. Eng.	30/130	Attending FT
Rachelle	African Amer.	Pre-Algebra	Chem. Eng.	99/132	Attending FT
Marco	Mexican	Calculus I	Chem. Eng.	132/132	Graduated
Carly	White	Calculus I	Civil Eng.	105/130	Attending FT

Analysis of Participants' Profiles

In this section, I present a short narrative for each participant as a means of introducing them and providing some important context. Lubeck (1985) shared the concept of "nested context," which is a means of exploring the participants' experiences within social and cultural environments. The contexts that I explored are the three that emerged as the most important contexts that influenced the underrepresented minority participants' path to college and selection of a STEM career path as well as persistence in a STEM program of study. The three contexts in order of importance are: socioeconomic status, first generation status, and academic preparation.

Socioeconomic Status

For students of higher socioeconomic status, the path to college can be quite linear and direct, while for others this may not be the case. Some lower socioeconomic

students may not even have the goal of college on their educational path, which could mean their schooling ends before or directly after high school. Oakes (1985) outlined how a student's socioeconomic status can influence subjective judgments that teachers and educators make related to a student's academic aptitude. These subjective judgments begin at an early age and can place students at an academic disadvantage, influencing the formation of their identity as a student who struggles in school or has difficulty learning. For low socioeconomic students, this can continue throughout their K-12 education, unless addressed. Banjeri (2006) discovered that class was a determining factor when it came to counseling high school students on their futures; meaning, counselors within secondary education were more likely to suggest and encourage affluent students to pursue a college education than their lower socioeconomic peers. If parents/guardians and the student alike lack the cultural capital (Bourdieu, 1986) to challenge the above situations, they continue unrecognized and the students' academic disadvantage can be compounded. Within the context of low socioeconomic status, absent of academic preparation and lacking the encouragement or counseling to pursue college, students may end their educational career and not continue on a path to college. Some may feel they are not cut out for this path. Bowles, Gintis, and Meyer (1999) asserted that parental economic status is passed on to children through personality traits that are learned and home and reinforced at school. They believe it is personality traits, as opposed to performance (grades in school or work performance), that impact a person's desire for higher education and their economic success in the workplace. Anderson and Kim (2006) posited that the economic status of a student's family is the most important of factors because it affects access to high-quality primary and secondary education. Low

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socioeconomic status students are less likely than middle and high socioeconomic status students to have completed a rigorous high school curriculum.

In this study, the participants self-reported socioeconomic status, which ranged from lower class to upper middle class. The split was even with 50% of the students reporting to be lower socioeconomic status (highlighted in Table 4). The students were aware of their economic need based on their FAFSA (Free Application for Federal Student Aid) Application. Fifty percent of the students reported to be from families of middle class incomes or above and reported that they did not have financial barriers.

Table 4

Students Who Reported Being Low Socioeconomic Status

Rachelle	Carlos	Manuel	Victoria	Jasmine
Marco	Carly	Andres	Mari	Ernesto

It should be noted that all students who graduated from a high school within the state qualified for the state's legislative lottery scholarship, which covered in-state college tuition. The lottery scholarship covers eight consecutive semesters of tuition (starting the second semester, after student establishes a 2.5 GPA) and makes it possible for students to complete a degree and leave college with little to no student debt. In order to continue to receive the scholarship, students must maintain a GPA of 2.5 or higher. There is an additional bridge scholarship that students can apply for that will cover the students' first academic semester in college. The state's lottery scholarship is an important financial support for all students, but it is especially helpful for those of lower socioeconomic status. Some of the participants in the study reported that they could not have considered attending college because of the expense had there not been a legislative

lottery scholarship. This scholarship enabled students from lower socioeconomic status

to enroll in and attend college full-time.

Low Socioeconomic Status: Carlos and Rachelle

Within the context of low socioeconomic status, I begin by introducing two

students, Carlos and Rachelle, who fell within the intersection of all three contexts, which

placed them at a greater disadvantage than others. Both participants shared experiences

of not being on a direct path to college because people in their school, community, and

family had low expectations for them. They expressed motivation to earn a better living

than their parents, which inspired them to continue their education in college. Even

though the general message they received was, "you are not college material," they found

their path to college through the STEM PREP program and continued to persist.

Carlos

Carlos, an Hispanic student from an urban area, described his family as poor.

Carlos's parents were married and both worked very hard in low-income jobs. He felt as

though they never really pushed him in high school nor did they urge him to attend

college. While he was in high school they used to tell him to do homework and study but

they never really monitored or enforced the behaviors necessary to instill good study

habits or achieve good grades. Carlos described telling his father about his sudden, last

minute decision to attend the university:

> Money always comes and goes, especially if you don't have a degree.
>
> And my parents, I remember telling my father I think I might go to
>
> college. And I remember him telling me that college is for 'smart people.'
>
> Because my parents have always been: do your homework, study, read

your book. You should do this. But they did not force me. So he was just

kind of like 'I don't think he's going to make it in college.'

Ultimately, as Carlos persisted in college, his father was proud of his

accomplishments. But initially, his father did not believe he should pursue college

because he did not believe he fit the image of 'smart people.' Carlos also shared how his

peers from high school responded to his decision to go to college and pursue chemical

engineering:

Chemical engineering? Isn't that all math, calculus and all that? You are

not going to make it! They would just tell me you should do something

less 'violent'… they always used to tell me. Because they would always

say you are going to get jacked up, as in beat up, by chemical engineering

and all the math.

In addition to low expectations from family and peers, Carlos also knew that

college was expensive and his parents did not have the money to help him with any

college expenses. Carlos, and other low socioeconomic students, have concerns about

how they could afford college. Both of these students, Carlos and Rachelle, did not have

knowledge of financial aid nor did they know about scholarships, even when the state

lottery had a program that would pay for in-state students to attend an in-state college or

university. While they may have heard about "the lottery scholarship" in name only, they

simply did not understand how it worked, if they qualified, and what they would need to

do to maintain the scholarship. Since their parents did not know the information either,

they were unable to gain the knowledge from within their family as others in middle class

families would. In short, with the lack of parental support or belief that they could be

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successful in college, low socioeconomic students are left on their own in decide about their future education and must make a major leap to venture into what is perceived as new territory.

Carlos shared that when he was graduating from high school with a "D" average his plan was to just continue working at his minimum wage job. "In high school I was working in a fast food restaurant from my sophomore year, all the way to my senior year. In high school you think a pay check of $200 is good." He continued on to explain how he had changed his mind about this and specifically who had saved him. In reflecting on his fluke encounter with the STEM PREP coordinator, who greatly influenced him to go to college, he stated:

> I probably wouldn't be here to tell you the truth. I probably would have
> been at [the local community college] or maybe just at my job at the
> burger stand. It is just crazy how that one situation in life could turn my
> path around.

Carlos described himself as a student that had fun in high school, was a member of the homecoming court, did not study, and never really took his academics very seriously. Hence, he really had no plan to go to college after high school until one day when he met the program coordinator of STEM PREP at a career fair. The story is best described in his words:

> It is a really funny story. In high school you know how they have career
> fairs. At one of the tables it was the coordinator [of STEM PREP] and he
> was passing out flyers and pamphlets. But, I noticed in our high school
> not a lot of students were interested in engineering. They thought, oh math

or science... dorks! So I kind of felt bad and I thought I would just go

check it out… go see how it is. Here is this guy he is not getting any

attention so I'll just go over there and see what he has to offer. He starts

telling me there is this program that I should sign up for. After a while I

totally forgot about even signing up to join [STEM PREP]. So later I got a

call from him asking if I was interested. I kind of did not remember this.

And then my memory came back and I was like, oh that guy from the

career fair. So I said let me think about it. I had other plans during the

summer to work, to actually work. After a while I sat there thinking about

it… and maybe this is what I want to do. So that is the beginning of what

I tell people is my story. I believe that everything happens for a reason.

So I agreed to join the program.

Carlos' story shows how his chance meeting of the coordinator changed the

course of his education. If he had not met the coordinator while still in high school, he

would not have proceeded directly to college; and it is possible that he may not have

made it to college at all without having participated in the four-week transition program.

Carlos's college experience was a bit rocky at first, however things had stabilized after

his first two years and he has persisted to his third year and completed about half of his

chemical engineering credits. While Carlos shared that he did not take high school

seriously, he only completed the required math classes to graduate and mostly got Ds, he

began to take STEM PREP math class seriously and worked hard on his homework. As a

result, he placed into college algebra II.

Rachelle

Rachelle grew up influenced by several cultures but identifies herself as African American. Her ethnicities include: African American, Vietnamese, Scottish, and Native American (Black foot Indian). While she has a diverse mix of ethnicities, she shared that people mostly just see her as black. Rachelle told me that she grew up poor. Her parents had divorced when she was in elementary school and she was raised by her single mother, who was an immigrant to the United States. While her mother worked very hard at her night shift job, she simply did not earn enough to land them in the middle class. When Rachelle described why she first decided to go to college, she said, "I guess the idea that you know I want to make better than what my parents provided me. You know because I grew up in a single parent home and I kind of do not want to go through what my mom went through." Rachelle expressed that she wanted to get a degree that would help earn her enough money to not always be struggling financially. Her parents' divorce had a profound effect on her, impacting her socioeconomic status as well as hindering her academic preparation throughout secondary education. She described her experience:

> When my parents divorced, I kind of shut down, everywhere. I did good
> in 3rd grade, but once I shut down, I kind of fell off the railing in 4th grade.
> So they put me in special education for 5th grade. And then they put me in
> special education for 6th grade and 7th grade. I felt like I was mediocre, or
> really, really low. They put me with a lot of kids who had behavioral
> issues or developmental issues. And that wasn't me, so I just stopped
> applying myself. I knew I had to wean myself away from that. So in
> order for me to pull myself out of that situation… and my mom saw it, but

she didn't really know what special education was because she is not from this country. So in eighth grade she pulled me out and she put me in Catholic school. And that's what got me out of there. And that's when I met my teacher who got me involved in NSBE [National Society of Black Engineers]. So for 8th grade I was in private school for a year. And once I went [back] to public high school [9th grade] I went right into honors and regular education classes.

While leaving public school for a year and attending private school became a strategy for her to get out of special education, Rachelle was left with deficiencies in her learning between fourth and eighth grade, especially in math. She described herself as not being "gung ho" for math in high school. "In high school you wonder, why am I taking algebra? Geometry? What's the point? They don't really tell you real-life applications or if they do it is way over your head and you are like, why do I care about that?" In her early years in high school Rachelle was involved in NSBE but did not yet know that she wanted to study engineering. She shared how in high school her advisors never really counseled her. In hindsight, she realized that she was given little to no advisement:

I feel like the school picked and chose the students they wanted to put in more complicated classes. Because although I did really well in algebra I, II, and geometry, instead of suggesting I take a dual credit, pre-calculus class [at the local university], my advisor didn't really advise me to do so. So when I went to college I was stuck with all these classes that I could

seriously have taken when I was in high school, for free. I feel kind of

gypped.

The lack of advisement impacted Rachelle because she did not take four years of

math in high school and the math curriculum that she did complete did not equate to

passing scores in math on the ACT and/or the COMPASS placement (used by the

University).   She shared this about her high school experience:

In high school I didn't really get advised. It was just fill out the

paperwork and move forward. So I felt I could have been prepared better

in high school. But, they kind of pushed me along like every other

student. With better advice, I think I would have come to college a lot

better prepared.

Rachelle's experience illustrates how the lack of cultural capital (Bourdieu, 1986)

influences one's ability to navigate through systems and within institutions. In her case,

she also did not have a cultural capital agent within her family who could help to

advocate for her and ensure she took math all four years of high school. For students like

Rachelle who come from a low socioeconomic family, it becomes important to gain the

help of a cultural capital agent, outside the family, who understands how to navigate

systems of education and can advise and advocate for her best interest.

During STEM PREP, students who did not place into college level math based on

their ACT (college entrance exam) scores are given the opportunity to take the

COMPASS (college placement exam) at the end of the program. Rachelle's score on the

COMPASS exam placed her into the lowest math class at the university, which was pre-

algebra; meaning she now needed to take and pass five math classes (pre-algebra,

intermediate algebra, algebra II, trigonometry, and pre-calculus), before she could take the first math class (calculus I) on the chemical engineering list of required classes. She basically repeated math classes that she had previously taken in high school, leaving one to question the rigor of her high school curriculum. The fact that Rachelle did not understand future college requirements (nor was her mother able to advise her on the topic) combined with the lack of advisement at school from her counselors, left her underprepared for starting a STEM program. Even with the four-week STEM PREP math course, Rachelle placed into pre-algebra. Because she had to start in pre-algebra, it added a substantial amount of time (approximately 2 academic years, including summer semester) before she could officially begin her program of study in chemical engineering.

In addition to her lack of academic preparation in math, Rachelle had some health issues that functioned as a barrier to her being able to begin the chemical engineering program of study until her third year of college. She suffered from both a personal medical issue as well as her mother's serious health issue (lung cancer) within her first two years at the university. Both of these health issues impacted her GPA and ultimately extended her academic career. As Rachelle stated, "I am now a sophomore in the chemical engineering department but I am a fifth year senior." This demonstrates how it took her three years of going to college full-time to get to the point where she could start in chemical engineering, which in general is where academically prepared students begin.

First generation Status: Victoria, Manuel, Marco, and Mari

First generation status is assigned to college bound students whose parents do not hold a degree in higher education (neither a two-year AA, nor a Bachelor's degree),

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meaning the student is the first generation in their family to attend college. In this study,

60% of the participants were first generation students (highlighted in Table 5).

Table 5

First generation Status Students

Rachelle	Carlos	Manuel	Victoria	Marco
Mari	Carly	Andres	Jasmine	Ernesto

It is important to note that parents with a college degree are generally able to

advise their children about pursuing degrees at four-year institutions. The research

suggests that first generation students are not likely to have ready access to information

on how to apply to, attend, or navigate college from their family, peer or social networks

(Deil-Amen, 2011). Although the parents of the first generation participants in this study

did not know the process for applying to college, these students created their own path to

college, with the goal of pursuing a STEM program of study, and managed to persist into

their third semester or beyond at a four-year, research institution. I introduce Victoria,

Manuel, Marco, and Mari in the context of first generation status.

Victoria

Victoria is an Hispanic student who attended a rural high school. She shared that

her mom had taken one or two vocational classes in her lifetime, but did not go to school

to obtain a certificate or a degree. Victoria grew up bilingual, speaking both Spanish and

English at home. She explained how some of her extended family members only speak

Spanish so she is not exactly sure how much they understand about her field of study.

> I am not sure how they feel about STEM. I think they just sort of, they are
>
> a little bit impressed because they don't know what I am talking about. It

is kind of hard to describe to them, especially because I have to do it in

Spanish. It is harder because engineering is technical.

As a first generation student Victoria relied heavily on getting information on her field of study (civil engineering) and college from sources outside of her family. In a reflective email, she reported her appreciation for programs that inspired her to pursue a STEM degree:

> I feel like I've been very lucky and had a greater opportunity for success
> because of programs like Mid School PREP and STEM PREP. Without
> Mid School PREP, I'm not sure that I would have pursued a STEM degree
> and if I had, I would not have been as knowledgeable about what it
> entailed.

Victoria was fortunate to have a middle school science teacher who persuaded her to attend a summer STEM program at a local, land grant university for three summers in a row. The program was expressly designed to get middle school students engaged in science and technology programs of study from an early age. In the program, they enriched the students' math education and applied this knowledge experientially with science experiments. Without this program, she would not have been as prepared for STEM. She shared information about her high school experience:

> I came from a poorer school… If our school had had more money, though,
> I think all students would have a chance at being better prepared for
> college. Compared to bigger schools [in urban areas], I don't think we
> were as well prepared. Others just had more options and I think their
> coursework was more rigorous than ours. Some people just didn't have

the foresight to prepare from a younger age like I did, thanks to my

participation in middle school STEM summer camp.

Victoria recognized that her participation in the summer STEM program for

middle school students, at the land grant university near her, played an important role in

her math preparation and exposure to STEM as well as her career selection. Being that

she was first generation status, the program contributed to her decision to go to college

and pursue STEM. She never questioned whether or not she would go to college; she just

wondered where she would go. Victoria maintained a high GPA in high school and she

earned a full scholarship to the University as a National Hispanic Merit Scholar.

Manuel

"The man who says he can and the man who says he can't are both right." -Manuel

Manuel, a first generation, Hispanic student who attended a rural high school,

shared with me the above quote. He explained how he was from a family of eight who

lived in a really small town. His high school simply didn't have the resources that other

schools had and did not offer advanced math classes. All that he had available was dual

credit classes that could be taken through a university branch campus. As a result,

Manuel felt that his high school really did not prepare him that well for college. Since

Manuel knew that he wanted to go to college and that he wanted to study engineering, he

realized on his own in his sophomore year that he needed to come up with a plan to

maximize his mathematics instruction while in high school. The highest math class he

could take was algebra II. So he devised a plan to complete both trigonometry and pre-

calculus as dual credit classes. He shared his math experiences in high school:

> I had very little access to other types of math classes. I have always been
>
> good at math, but it didn't really challenge me all that much. My teachers

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always supported me, but they didn't really challenge me. To be honest

my pre-calculus class in high school was my teacher giving me a calculus

book and saying do problems. It was like a self-study thing. I sat in a

[dual credit] trig class doing calculus while everyone else was doing trig.

Me doing calculus problems got me trig credit for college. I did calculus

problems in high school and I got trig credit for it, it didn't make sense.

Although he devised a means of completing a self-study in pre-calculus, his high

school only had a means of granting him trig credit through the branch campus's dual

credit offerings. His efforts were successful and his ACT math score placed him into

college level calculus.

As a first generation student, Manuel is forging new ground for his family. Not

only is he going to college, he chose a very challenging STEM major, electrical

engineering. He shared,

I wanted a major that was challenging for me, because high school wasn't.

I wanted something to push me. It is definitely new in my family for

someone to be doing engineering. But they never really told me to do

anything so I just chose it and they are happy with me doing whatever I

want to do.

His words demonstrate how a first generation student finds their own way towards

a degree program.

Marco

Another student, Marco, also held first generation status because neither his

parents, nor his grandparents (who were his guardians) held a certificate or degree from

college. Marco was born and raised in Mexico and he arrived in the United States for his last year of high school, speaking Spanish only. Marco's parents were never married. When he was two years old, his mother married an American man and moved to the United Stated, leaving him behind in Mexico to be raised by his grandparents. It took until he was a teenager for her to gain her U.S. citizenship. At that point, Marco moved to the United States to finish high school and attend college. He attended the local, urban high school in his mother's neighborhood. Marco recounts his experience as a senior at an American high school:

> The first semester was really tough in American high school. I had to take extra classes, outside of the regular hours, to meet the graduation requirements. I did not know English. I learned it here my first year. [The urban high school] doesn't have a big Latino population so I didn't have any friends who could speak Spanish, so it made me learn English faster, I guess. I don't remember most of what I did that year. It seems like everything was mashed together. Between not understanding anything teachers were saying and trying to learn English, it wasn't a very good experience.

While in high school in Mexico, Marco had already completed his core courses as well as his courses in his self-selected area of interest, math. In Mexico, he had already taken pre-calculus, advanced physics, and chemistry. With his language barrier he was not able to advocate for himself at his American high school and he just completed the classes they told him to take so he could receive his diploma and attend university, his ultimate goal. He shared these details:

It turned out [at the American high school] that they put me in algebra II, which was good because that's the math requirement I needed to graduate, but it was bad because in Mexico I had already taken it and I had even taken pre-calculus classes. I ended up getting perfect scores on everything because it was just a refreshing of what I had taken before. At [the American high school] I took mostly English, U.S. History, and those types of classes. I ended up taking mostly classes in the humanities. Definitely the key point of choosing my career was when I was at the high school in Mexico. And of course, I did most of my high school in Mexico.

For Marco, completing the U.S. requirements for high school was what he needed to do to gain access to college. Since Marco predominantly spoke Spanish his first year in the United States, a friend of his Mother, who was also a Latino, recommended that he visit *El Centro de la Raza,* a student support group, at the university. He shared how his visits to *El Centro de la Raza* ultimately linked him to the STEM PREP program:

I went to visit *El Centro de la Raza* and they were the ones who told me about Hispanic day at the University, when they bring Hispanics, who are about to graduate from high school, for one day to tour the campus and apply to school. It was that day [Hispanic day] that I learned about the STEM PREP.

Due to Marco's strong schooling in math and science in Mexico, combined with the fact that he had a math teacher there who really pushed him towards a science field, he had decided early on in high school that he wanted to become an engineer. Marco's strong math background from Mexico, along with his four weeks of STEM PREP math,

placed him into calculus I. As a recent immigrant the English language was a bigger barrier for Marco than math. He recalled that he did not do well in high school on the ACT English/Writing exam and would have been placed in remedial English. However, his experience during STEM PREP forced him to develop his English language skills further. Living on campus for STEM PREP represented the first time that he was not around anyone who was fluent in Spanish. The combination of being immersed in English coupled with the STEM PREP English course enabled him to achieve a score on the COMPASS placement exam that placed him into English 101 (college level English).

For Marco, his personal dream of becoming an engineer compelled him to go to college to achieve that dream. Of the 10 participants in the study, Marco is the one student who successfully graduated as a chemical engineer from the southwestern university. Marco completed his degree program in 4.5 years, but stayed for an additional semester to participate in an intensive research program that is designed to prepare undergraduates for graduate work in STEM related fields. While he was in this program, he was greatly influenced by a faculty member to pursue a graduate program. He shared, "They really try to encourage the underrepresented minorities, especially Latinos. They really want to increase the percentage of minorities in STEM fields." As a result of his experience with faculty in this program, Marco is now enrolled in a Ph.D. program at a northwestern university studying engineering and conducting research related to semiconductors.

Mari

"As Navajos we really look to our leaders. Chief Manuelito was one of them and he really thrived on education. He said, 'education is the ladder to all our success, tell our people to take it.'" -Mari

Mari is a Native American student whose parents did not attend college, which placed her in first generation status. Her parents divorced when she was a young girl and she was raised by her single mother. While her mother did not have a certificate or college degree, she had managed to work her way up to a manager at the company over several decades and was paid well enough to place them into a high socioeconomic status. Mari attended a small, private middle and high school that set very high standards and focused on STEM program preparation. Her high school boasts that 90-100% of their students in each graduating class attend college. As a result of her rigorous academic STEM focus in high school, Mari was the only participant in the study whose first college math class was calculus II (based on her score on the AP Calculus exam she completed in high school). While Mari's mother was very supportive, she did not necessarily know the ins and outs of college. Mari shared how she learned a lot about college expectations and readiness from her teachers. She described what teachers did to help all students at her school:

> All of our teachers were geared for us to get ready for college right when
> we became freshman. They had us looking at colleges throughout high
> school and scholarships. Everything. They helped us look for rides to get
> to our tours, they would sponsor tours, they would do everything they
> could to get us into college. They would have the ACT prep exams
> [PLAN] for us, three times before you take the ACT or AP. They had
> study sessions for the AP Calc exam, which was brutal. They would help
> your get rides to your exams if your parents couldn't do it. They would
> take you to different learning experiences around the area. They would

have people come in from Universities and alumni that had graduated.

Now most of our senior class is going to college.

Mari's quote illustrated the type and extent of social or cultural capital that she gained from interacting with her teachers and staff at her private school. It is clear they endeavored to maintain the school's <u>better than </u>90% college attendance rate. One of her favorite high school teachers influenced her to participate in an honors math camp in a neighboring state one summer. Later, this same teacher introduced her to a summer program on transportation at the state's research university, which she participated in for two summers. She shared this about the summer program, "it focuses a lot on how engineering and transportation go with each other. We would take tours during the summer for three to four weeks. We went to construction sites, the Air Force base, and we even made solar cars. We did a lot of stuff for that." Her summer program experiences coupled with her math preparation strongly influenced her to decision to pursue civil engineering. She shared her own words on how she came to decide on engineering before she arrived at college:

> There are these ruins back home in the canyon. They are still standing
> after years and years. This is literally my back yard. I played down there.
> I wanted to know why they were built, how they were built, how they are
> still standing today even though so many others have crumbled. It is made
> out of just mud. I wanted to look at it to see if there is anything from back
> then that we can use now to help with structures.

Mari also expressed her goal for the future to return home and give back to her community:

Back home the roads are really bad. Really, really bad! The buildings

they have had to renovate like two or three times since they have been

built.   People in rural areas want electricity, water, internet service… stuff

the city already has, but rural areas don't. Once I am done, with my

experience I want to open my own company. To bring water, electricity,

and basic stuff that we have now to people who don't have it.

While Mari held first generation status, her socioeconomic status allowed her to

attend private school from K-12. Her experiences at private school were positive and

they greatly enhanced her cultural capital related to applying to college and navigating

systems of higher education.

Academic Preparation

The third context I discuss is academic preparation, meaning understanding how

students' high schools prepared them for college. Now that they have persisted to or

beyond their third semester of college, they have shared how they think their high school

either prepared or did not prepare them for STEM. Each participant has completed the

STEM PREP, which was their first major interaction with other students from many

different high schools. Since then, students have had many interactions with other

students in study groups as well as with student tutors, which may have provided them

with a gauge of how they felt about their own high school preparation.

Students who complete high level mathematics courses (for example,

trigonometry, pre-calculus, calculus) are more than twice as likely to graduate from

college as compared to their peers who only complete basic mathematics - algebra

(Adelman, 2006; Conley, 2008). Math is an especially important content area for

students going into a STEM field since they require the highest levels of college math to obtain a degree. Faculty from STEM PREP reported that math proficiency was a major factor for students entering a STEM program of study. They encountered a wide range of students that began the STEM PREP program with math skill levels that ranged from fractions (basic math) to mastery of calculus. The faculty observed a marked difference between students who attended urban versus rural high schools. In general, they felt that students who attended rural schools did not get as rigorous math instruction when compared to their peers at urban schools. In this study, students who reported they were not prepared cited that they did not get the proper math education in high school for various reasons.

The students in this context will be presented in one of the two categories (1) academically prepared or (2) not academically prepared, which was a self-reported measure, balanced with the math level they placed into after completing the STEM PREP program. In addition, I will share some of their stories about why they felt they were prepared or underprepared in math. Sixty percent of the participants reported and demonstrated by their first college math class that they were academically prepared to begin in a STEM program. The other 40% reported that they were not academically prepared for college level math and are highlighted in Table 6. These four students placed into algebra II or below.

Table 6

Academically Under-prepared in Math

Rachelle	Carlos	Andres	Jasmine	Victoria
Marco	Manuel	Carly	Mari	Ernesto

Rachelle, Carlos, Andres, and Jasmine all benefited from participating in STEM

PREP. The academic enrichment classes and transition to college initiatives supported

them in their endeavor to enter a STEM program of study although they arrived under-

prepared.

Academically Prepared: Ernesto and Carly

Ernesto

Ernesto is an Hispanic male who attended a suburban high school. He described

his high school as having a high dropout rate. He felt that he took initiative in high

school by taking four AP classes, two of which were in STEM (AP Chemistry, AP

Calculus AB/BC).   He shared a little about his math experience in K-12:

> I have always noticed that I have been better at math than at English or
>
> composition. So I really pursued math. I took algebra pretty early on. I
>
> took it in seventh grade and then I kind of was always a year ahead of
>
> everyone else in mathematics until that lead to AP Calculus. And that
>
> really got me into thinking of engineering as a career path. Since
>
> engineering requires a lot of math and I like math and I am good at it too.
>
> So if you really like something and you are really good at it why not
>
> pursue it?

In addition to recognizing his ability to do math, Ernesto's father had a passion

for technology that he shared with his son. Ernesto stated:

> Probably my first role model would be my dad. He is very technical
>
> oriented. He showed me what a computer is and all the cool stuff you can
>
> do with it. And I guess that inspired me to pursue something like that. I

really like math and science so that made me think of engineering. From

there I narrowed it down from engineering to my passion for computers,

computer engineering.

Ernesto's quote shows how his father had a strong influence on developing his passion

and choosing a STEM career path. His father "showing" him the computer entailed

taking it apart, learning about the individual components, and learning how to build a

computer from scratch. Fortunately for him, his cultural capital was gained from within

his family unit. Ernesto's first college level math class was calculus I. His strong math

skills allowed him to get a part-time job at the university as a math tutor, helping other

students to learn math and succeed in college.

Carly

Carly is an Anglo woman who was allowed to participate in STEM PREP because

the female gender is underrepresented in engineering. Carly attended an urban high

school that she felt prepared her for college. She shared, "I'd say it prepared me pretty

well. I always took honors or AP classes which kind of geared you towards college and

get you ready for test taking." Carly described herself as someone who really liked math

(especially algebra) and had good experiences in mathematics throughout high school.

Carly shared that her father had a strong influence on her pursuing engineering. Her dad

started decades ago, working as a janitor, at the National Labs. He had his B.S. in

Biology and eventually worked his way up to professional jobs and retired from the labs.

Carly articulated how her father influenced her:

My dad is a total advocate for college. He has always been backing

science and math. Because he says that it is always going to have good

paying jobs. So he has always been influential towards that. But, I always

feel like I should not let him down. He would like to see something

greater out of us than just the regular stuff. He is very up on getting the

most education we can so that has really helped.

Carly shared that since elementary school her father stressed the importance of

getting a good education and going to college. In her own words, "I have just been in

programs learning, all of my life." A lot of this was attributed to her father instilling the

value of education.

Carly's physics teacher in high school was another advocate who pushed her to

apply to STEM PREP and encouraged her toward engineering. While Carly knew she

wanted to pursue engineering as a major, she did not know what field she wanted to go

into until after she had attended STEM PREP, which provided presentations on STEM

careers. She recounts how STEM PREP presentations helped her decide on a specific

field of study:

> We would do tours of the different engineering programs or even physics
>
> and chemistry. The tours really helped me. I knew I wanted to do
>
> engineering and I was going to do basic or general engineering because I
>
> didn't really know what each entailed. I chose civil engineering because
>
> the presentation that they gave us… it was like you can do so many
>
> different things and they are very helpful to the community. And that's
>
> what I wanted to do. Civil engineering is very public, meaning you do a
>
> lot of jobs for the public. You are helping out society, not only the people

but the environment they live in. And I learned about it from STEM

PREP presentations.

The combination of having her father as a strong advocate for pursuing a STEM degree program coupled with her physics teacher encouraging her to attend STEM PREP helped Carly to be academically prepared for and to pursue engineering. Carly's ACT scores were high enough to allow her to take calculus I as her first college level math class. Her strong math skills also allowed her to work part-time at the university as a math tutor. The primary benefit of her attending STEM PREP was that it helped her determine her field of study prior to beginning college, making her four years in college focused on completing the specific requirements for civil engineering. Whereas some students can get set back in college due to switching their major midstream or remaining undecided for too long, Carly was able to avoid this by knowing exactly what she wanted to study before she began at the university.

Not Academically Prepared: Andres and Jasmine

One common factor shared by students who reported they were not academically prepared by their high school was not taking advanced math classes. While some students' schools offered these classes, they did not know that they should be taking them. Other students' high schools offered honors and AP math classes and they did not have access to these types of classes. The two students (Manuel and Jasmine) whose high schools did not offer advanced honors or AP math classes devised alternative plans for themselves in order to gain access to the math content they thought they needed.

Andres

Andres is an Hispanic male student who realized in hindsight that in high school you have to be your own advocate. His urban high school had honors and AP classes available for students to take, but he did not get the proper counseling or advice to take these classes. He shared information about conversations that he had with many of his friends who went to private school. These friends were urged to take advanced math classes while he could just fly under the radar in public school and no one advised him to continue math. He expressed it this way:

> The education [in public school] is there for you, but you have to be your
> own advocate. If you want to get by and do the bare minimum that can
> happen. But if you want to actually put yourself into AP courses then the
> great thing is that they offer those classes and the teachers were really
> good. I always wish I had taken more math classes in high school,
> especially going into engineering. I did my math and you only have to
> take up to algebra II. And I wish someone had forced me to take math
> every year, rather than recommend it. Cause when I was in 10th grade I
> didn't know what I wanted to be and I didn't know that it was going to be
> heavily math focused. I wish I had known that I could be taking college
> level math classes while in high school. The education is there for you,
> you just have to know you want it and you have to know where to get it.

Andres highlighted an important issue when one lacks cultural capital, they may miss opportunities that are there for them. He laments the fact that no one forced him to take math his junior and senior years of high school. The absence of math for two years

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may have caused him to lose math skills as he was not practicing math each year. In

Andres' case, even though he had completed the algebra II requirement to graduate from

high school, when he took the ACT and the COMPASS placement, his scores in math

were low, placing him into pre-algebra in college. So in a sense he had to retake his high

school math classes making it unclear what he had actually learned in high school math.

It is possible that his school's math classes were subpar and did not teach the content at a

rigorous level.

Even though Andres had to complete five college math classes before taking

college level calculus, he felt that it was the best thing that ever happened to him. He

expressed that he felt very fortunate because as a result of having to take pre-algebra he

met a great college professor who helped him gain a solid algebra foundation, which

allowed him to complete his advanced math classes required for engineering (calculus I,

II, and differential equations). He explained that she went out of her way to help him

during office hours with areas that he was struggling with:

> I had the best pre-algebra and algebra teacher. She taught me the basics so
>
> well. She studied with me every day and really helped me. I think she was
>
> probably my biggest advocate. She wasn't just a math teacher. She got
>
> her degree in engineering as well. She knew the kind of stuff I was going
>
> through, the type of classes I was taking. You know, she really cared. We
>
> would talk engineering for hours. She was that kind of teacher. She really
>
> thought I was something special because I came from pre-algebra and
>
> went through all the engineering based math classes you need to finish
>
> your degree. It is something she hasn't seen before.

With the extra help provided by this professor, Andres was able to successfully pass all of his required engineering math classes. Although he arrived at college underprepared in math, he was fortunate to have early success with pre-algebra and algebra classes which allowed him to pursue his desired field of study, civil engineering.

Jasmine

Jasmine, a Native American student, realized in high school that in order to do what she wanted to do in life, she needed a plan. Like Manuel, she attended a rural high school that did not offer advanced coursework, but she did not have access to dual credit classes. She described a little bit of her high school experience, "My teachers in [rural town] mostly weren't very qualified. Mostly it was their secondary job and they didn't really have a concentration in math. I think it was just due to a shortage of teachers and stuff like that. So before my math was a little weak." This is what spurred her to change her course. However, the plan that she devised to improve her high school education was much more radical than Manuel's self-study. Early in her junior year of high school, she came to the conclusion that she needed to make a change because her high school was not preparing her for what she wanted to do. Jasmine's older brother was married and he lived in an urban area in a neighboring state. Jasmine pitched the idea to her parents that she would move away to live with her brother and sister-in law, allowing her to attend an urban high school, which would greatly improve her education and better prepare her for college. Her plan entailed moving out of her parents' home, across state lines, and transitioning to a new high school in her junior year. While her parents were not excited about her leaving home early and moving away, they ultimately allowed her to move so she could pursue her dreams. Jasmine shared:

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Before I had to move I was thinking about what I would do with my life. I

thought about the area I was in. Not very many people leave that area.

They don't get out, they don't explore. They just stay in that little, rural

area. When I thought about that I just thought, why am I here if I want to

do all these things? I think that was the main drive that I had and with that

I guess my self-esteem went up, considering that I could do more. I talked

to a counselor and she would say the things that you want they aren't

really offered here. So I came up with the idea and I talked with my

parents and of course they were hesitant. Because I was their youngest

and I would be leaving so early. I talked about it with my brother and

with his wife and she said it was possible. Three weeks later I left.

Jasmine went on to describe how moving to the urban school helped to provide

her with access to advanced classes, clubs (academic enrichment), as well as college and

career presentations that were not available at her old school. Because she arrived at the

new school in her junior year she was able to take math up to trigonometry. She shared,

"That is the one thing I regret about high school. I should have left my old high school

earlier so I could have done algebra, algebra II, then trig, and go in the regular pattern

that everyone else had done [to calculus]. That just put me a little behind." Although she

was behind in math she gained access to more cultural capital at her new high school.

Jasmine shared how one of her physics teachers became a mentor:

I was lucky. I had this one teacher who I thought was just teaching

physics, but she got her degree in chemical engineering. She went to

[state engineering college] and she's a chemical engineer so I would talk

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to her about the major and she was very helpful to talk about her experiences. She kind of reinforced my interests.

Prior to meeting her Jasmine had thought about a field in math or science, but she had not necessarily come to engineering. She is now enrolled in the chemical engineering program at the University and attributes it to her conversations with her physics teacher in high school. During a presentation at her high school, she learned about the STEM PREP program and she applied. While in STEM PREP, she realized that she had math deficiencies in algebra, which she believed was content she missed at her original high school. Her ACT scores placed her into algebra II.

Each student who reported not being prepared by their high school, pointed specifically to the lack of quality math instruction or not having access to higher level math curriculum through their school or through dual credit. Andres pointed out that at his high school high level math classes were available, but you had to know how to access them and be highly motivated otherwise you would miss out on the opportunity. This highlights an example of how cultural capital plays an integral role in a student's life. For several participants, predominantly those who attended schools in rural areas, rigorous, advanced math classes were simply not offered at their high school, placing them at a disadvantage. When each of the participants arrived at college, it became clear to them that being underprepared in math was a barrier that impacted their ability to complete a STEM degree.

Intersection of All Three Contexts

Figure 6 illustrates where students fit in relation to the three contexts:
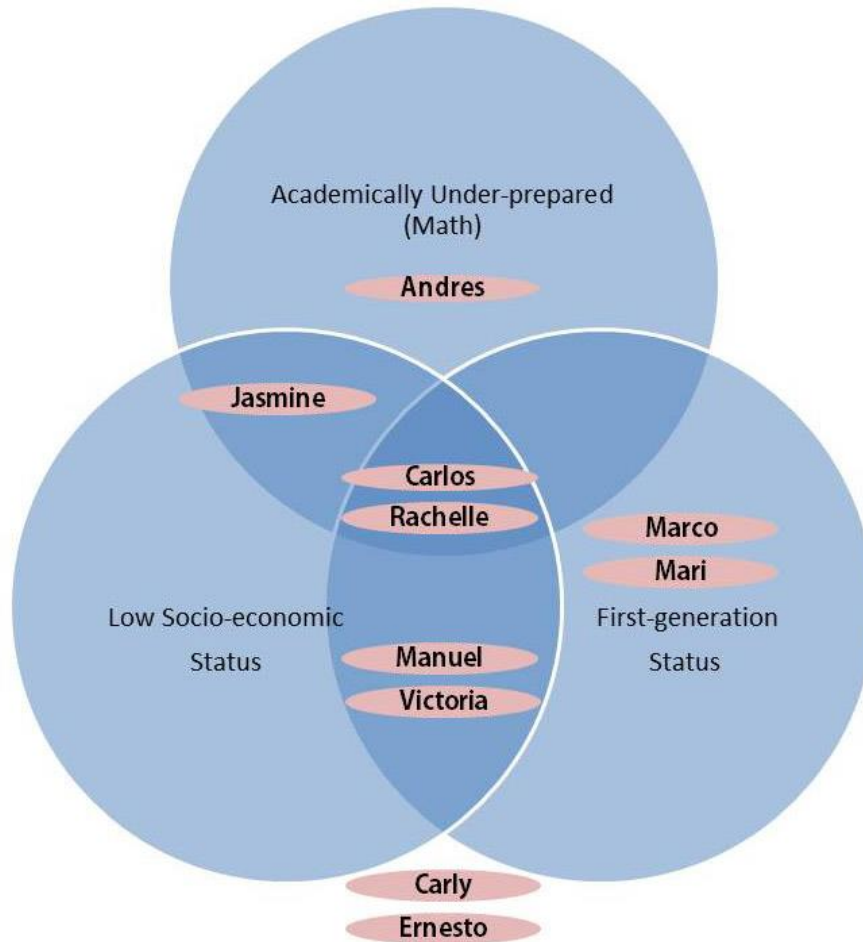
Figure 6. Intersection of Three Contexts

There were two students, Carly and Ernesto, who did not fall into any of the three contexts and they were the students who reported that they experienced no barriers and were successfully making their way through college. These two students reported being the most prepared academically for college and were also both employed as math tutors at the university's student assistance center. There was one male student, Andres, from a higher SES family who was not a first generation student but found himself underprepared in math after attending an urban high school that had low expectations for students in general. He reported that in hindsight he realized that advanced programs were available at his school, but he did not get advised to participate in these. While this

made high school easier at the time, he later regretted it when he decided to pursue a STEM degree.

The diagram highlights how half of the students fall at the intersection of two of the three contexts (Jasmine, Manuel, Victoria, Carlos, and Rachelle). In this study there are two students, Carlos and Rachelle, who fall at the intersection of all three contexts. It was these two students who reported the most barriers to persisting in college. In addition, they both estimated that they would have to stay in college for 5.5 to 7 years to make up lost credits and to complete their engineering degrees. Based on their stories, these two students, Carlos and Rachelle, experienced more barriers than other students, which included financial issues as well as personal health issues and/or family health issues. These issues impacted their grade point average and they had both failed classes during a semester, but found a way to get back their lottery scholarship, by making up classes and achieving a GPA of 2.5 or higher. They shared their trials and tribulations and recognized that their community had low expectations of them. Both of these students were very motivated to continue their education in spite of low expectations and maintained a strong desire to prove that they could successfully complete engineering degrees. Their biggest motivator was to make a better life for themselves.

Viewing the intersections of these contexts in relationship to the participants' experiences highlights the difference that cultural capital can have on a student's trajectory of being college bound and persisting towards degree completion.

Analysis of Supports for Persistence

In the previous section, I introduced the ten participants through one of the three contexts: socioeconomic status, first generation status, and academic preparation (both

prepared and underprepared). All of the participants in this study are considered to be "traditional" students because they began college immediately after they graduated from high school. In a few of the cases, the students may not necessarily have done this had it not been for the financial support of the state's legislative lottery scholarship, which requires one to enroll and begin right after high school in order to gain scholarship eligibility. All participants completed the STEM PREP program, an immersive bridge program at the University that was funded by the National Science Foundation as a means of helping underrepresented minority students to transition from high school and to persist in a STEM field of study. The coursework offered in the four week program was designed to help address deficiencies in math and English that underrepresented minorities may have and help to academically prepare them for college. Of the ten participants in the study, two students (Marco and Carlos) were able to place into a higher math classes due to their involvement in STEM PREP. Specifically, the STEM PREP math class helped both of them address deficiencies and gain a higher score on the COMPASS placement exam.

Each student in this study followed a different path to college, which generally was greatly influenced by their interaction with the three contexts outlined in the previous section, socioeconomic status, first generation status, and academic under-preparation in math. The context that had the most impact on the study's participants was socioeconomic status. This is consistent with Adelman's (2005) finding that socioeconomic status has a stronger relationship with college access and success than race or ethnicity. In fact, if the state did not offer a lottery scholarship, several of the students reported that they would not have been able to afford college. In general, low-

income students are less likely to have completed a rigorous high school curriculum in comparison to those students who come from middle- and upper-income families (Adelman, 2006). A family's income strongly correlates to the parents' education level. The students who experienced the greatest number of barriers and difficulties relating to access and persistence in college were those that fell at the intersection of all three contexts, lower socioeconomic status, first generation, academically underprepared (Carlos and Rachelle).

While the research question "how do underrepresented minority students persist in college?" seemingly focuses on persistence once the students arrive at college, the students shared experiences that clearly illustrated the importance of secondary education. Whether or not a student graduated from high school and continued on to college was determined by the quality of educational experiences they had prior to college (in K-12). Therefore, it became important for me to include pre-college academic preparation within the analysis. Students shared academic experiences from grades 6-12; hence, these years were established for the pre-college preparation. The lack of academic preparation did not necessarily present itself to the students involved until after they arrived at college and began interacting with students from other high schools, first in STEM PREP math and then later in their engineering classes. For the underrepresented minority participants in this study, it was important to examine how they created a path to college and persisted once they were enrolled. Learning about and understanding their secondary educational preparation was essential. There were marked differences in secondary education experiences for students from different socioeconomic statuses. Students from higher socioeconomic status were able to share information about

Advanced Placement (AP) classes and how they prepared them for college. Their story was simple and their path to college seemed clear for them; they went to high school, enrolled in college, and passed classes. For the other students, the path was not necessarily as linear and was laden with obstacles. They were able to identify pitfalls, areas where they felt they were not supported, nor were they advised appropriately in high school. When reflecting on their past experiences in grade 6-12, they could single out important teachers along the way who took the time to notice them, advise them, and help them out. They now knew, after persisting past their first year in college, whether or not their high school had prepared them for the academic expectations of college; and they could identify what they had to do that was different from other "main stream" students.

All of the participants' experiences shared in the interviews were reviewed, coded, and analyzed. In the process of analysis three key findings emerged from the study:

1. "Cultural capital agents" or "agencies" were integral in encouraging underrepresented minority students to go to college for STEM and helped students persist once in college
   a. Exposed students to STEM academic enrichment programs
   b. Helpful for all, but especially integral for first generation and female students
2. Lack of academic preparation (especially in math) increases the length of time in college and hence requires increased motivation and patience for persistence

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3. High impact socio-academic integration helps students to persist while developing cultural capital

    a. Faculty engagement (research assistantships, learning communities)

    b. Peer engagement (study groups, student academic organizations, learning communities)

    c. STEM PREP

    d. Career-related integration (Internships, career related part-time jobs)

Cultural Capital Agents

Bourdieu referred to cultural capital as the culmination of interpersonal skills, habits, manners, language, educational credentials, and behavior acquired throughout one's life (1986). Cultural capital is seamlessly transmitted from one's family based on their social class. Higher social class strongly correlates to more cultural capital that can be gained from the family. The participants in this study shared the barriers that students face when they are raised in a low socioeconomic status and they lack the cultural and social capital that their middle class peers possess. While there is a strong intergenerational status transmission process of personality traits (Bowles et al., 1999) it was acknowledged that on a micro scale the tendency to reproduce similar traits can be countered by social forces (for example; a teacher, shifts in school structures, new parental work experiences). A key finding was that all students who were low socioeconomic status and/or held the first generation status reported that they greatly benefited from having a mentor or "cultural capital agent" who supported their individual

development, advocated for them, guided them, and heavily advised them toward college enrollment, financial aid, and towards pursuing a STEM degree. It was these cultural capital agents who created a shift in the overall social forces and fostered new paths to STEM programs for students who traditionally would be tracked to other roles in life.

For the eight students who benefited from a cultural capital agent outside of a family member, this person, in every case a teacher in secondary education. For the two students who did not require an outside cultural capital agent, they shared that their father was their mentor and encouraged their interest in science and an engineering career. For the eight students who had utilized a cultural capital agent, they reported that they encountered them while they were in secondary education (grades 6-12), a time while their identity was forming. According to Erikson's (1980) development model this is Stage 5: Adolescence, when an individual is forming their identity; a time when they struggle to integrate many roles, for example: child, sibling, student, worker into their self-image. Ideally, a role model can help students in this time of identify formation to see themselves in the image of a college student who pursues a STEM field.

Cultural Capital Agent within the Family

For participants who were higher socioeconomic status, generally their cultural capital was gained seamlessly from their continued interaction within their family. These students shared how one or both parents had high expectations, cultivated their interests in math and science, and greatly influenced them to pursue a STEM field of study. Carly shared how her dad placed a great emphasis on learning throughout her life:

> My dad is a total advocate for college. So he really pushed us in school all throughout; elementary, middle, and high school. I have just been in

programs learning all of my life. He is very up on getting the most

education we can so it has really helped me. Also, he would give us

incentives to keep us doing well in school.

She also shared how her dad set high expectations for her relating to her degree

and influenced her initial degree selection:

It is also my dad's influence. At first I wanted to be a math teacher or a

second grade teacher. And my dad says, 'you should go as far as you can

and push yourself the most to complete an engineering degree. And if you

find out that you don't really want to do that it is always easier to go back

to do something simpler.' So that helped me.

Overall Carly followed her father's advice and continues towards her goal

because she does not want to disappoint him:

My dad is really big backing for my persistence. He says, 'always stay in

school and you are always going to learn something.' He has always been

backing science and math. Because he says, 'that is always going to be

good paying jobs.' So he was influential towards that. But, I always feel

like I should not let him down.

In a similar manner, Ernesto shared how his father's passion for technology and

computers inspired him:

Probably my first role model would be my dad. He is very technical

oriented. He showed me what a computer was and all the cool stuff you

can do with it. And I guess that inspired me to pursue something like that.

I narrowed it down from engineering to my passion for computers,

computer engineering.

Ernesto also shared how he was also inspired by a good math teacher:

Overall, my mentor was my father. He was my main inspiration. But, I

have also had some teachers along the way who have inspired me. I was

definitely inspired by my high school calculus teacher. I really liked that

calculus class. The teacher was really nice and she taught the material

well. That was around the time I realized that I wanted to do engineering.

Ernesto's exposure to the technical aspects of computers and semiconductors (through his

father) coupled with a good foundation in math education helped him to make what

seemed like a natural decision to pursue computer engineering. Having a cultural capital

agent within the family helped Ernesto to select a career to pursue while he was in high

school.

Impact for First generation Students

For participants in the study who held the status of first generation student it was

important that they have what I deem a "cultural capital agent" or a mentor. For most

students it was someone they met between 6th and 12th grade. In these cases, the mentor

(or person who advocated for them to pursue STEM) was a teacher who helped them to:

1) develop an interest in a STEM field, and/or 2) develop the cultural capital to enroll in

classes or enrichment programs that prepared them for college. One first generation male

student, Manuel, did not have a mentor or cultural capital agent. He essentially forged

his own independent path to engineering. However, for most STEM PREP students their

cultural capital agent played an important role. One of the STEM PREP faculty members

shared her perspective on students when they first arrive at college:

> Students just aren't prepared for the kind of rigor that they will encounter
>
> in college. A lot of them have been able to slide by without having to put
>
> in too much effort and then when they get into college it is sort of a shock.
>
> A lot of them aren't sure what to expect. Not only because they have not
>
> been to college before, but because many of them are first generation
>
> college students and so they don't have parents or guardians that can give
>
> them the kind of detailed advice that maybe some other students receive.
>
> And the bridge program gives them a built in group of friends and a
>
> support network. It really introduces them to faculty and students in the
>
> same area, in the kinds of careers they might pursue.

While all students reported benefits from their participation in STEM PREP, she

pointed out how the program especially supported first generation students by developing

their cultural and social capital. She also highlighted the important fact related to the

transition from high school to college. In general, students are not prepared for the

academic rigor once they arrive in college. This is another aspect of how STEM PREP

helped to transition students to the level of rigor expected in college.

Higher SES First generation Students: Mari and Marco

Both Mari and Marco were first generation students whose parents maintained a

high socioeconomic status, which allowed them to attend high schools that focused on

college preparation and STEM. In fact, they reported that their high schools had many

teachers that helped to expose them to rich, academic STEM opportunities. Their schools

also had a high percentage of students who went to college. It was evident from their stories that they gained cultural capital from teachers while in high school. This is an example of gaining cultural capital from people outside of the family.

In the case of Mari, her high school teachers highly recommended a math summer camp in a neighboring state.

I went to summer math camp between freshman and sophomore year, which focused on a lot of theoretical thinking, which really helped me. It was the honors summer math camp that [my teacher] suggested.

The following summer another teacher recommended that she apply to attend a summer transportation camp at the university for students interested in civil engineering. Both of the math and summer engineering programs provided Mari with exposure to the field and greatly influenced her decision to pursue civil engineering.

Marco shared this about his high school in Mexico, "Keeping a perspective, my school in Mexico was known as a top performing school and most students went to college." Like Mari, Marco had several teachers who exposed him to extracurricular opportunities in math and science. One teacher suggested he participate in math olympiads, an after school club that focused on math and reinforced practicing math. Once, at the math olympiads, he encountered another teacher who became a cultural capital agent for him. He shared a little about her, "She was a biologist by training, but she ended up teaching many classes. She really pushed me towards science fields, but not necessarily towards engineering." It was during this third year in high school that Marco decided to pursue engineering. Marco added, "Definitely the key point of

choosing my career was in high school in Mexico. And of course I did most of my high school in Mexico."

While Mari and Marco were first generation students, their socioeconomic status gained them access to high performing schools that had teachers who readily shared their cultural capital with students.

Lower Socioeconomic Students: Carlos, Rachelle, Victoria, and Manuel

Both Carlos and Rachelle were first generation students who reported attending very low performing high schools that left them underprepared for college. For the most part, they were not "expected" to attend college let alone succeed or persist academically. As a consequence, for them their cultural capital agent was a necessity or they may have not found their way to the university and pursued a STEM field of study. Carlos's parents simply did not see him as college material and if it were not for his chance meeting with the STEM PREP coordinator at high school one day, he likely would not have enrolled in college. The program coordinator of STEM PREP changed Carlos's educational path by presenting him with the opportunity to participate in the STEM PREP program. Once Carlos completed this program, he realized that he was college material and he would like to pursue a STEM career so he could have a better future.

Rachelle's mother was an immigrant and was learning English as well as trying to learn to navigate the systems in a new country. She was unfamiliar with the education system in the United States and was unable to help or advise Rachelle in secondary education or beyond. Rachelle shared how she had to do everything herself, including her FAFSA application, with no advisement from her mother or a school counselor.

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Fortunately for Rachelle, while at a private school for the 8th grade year, she met her

science teacher who highly suggested that she participate in the National Society for

Black Engineers (NSBE). The local chapter of NSBE exposed Rachelle to rocketry and

robotics, which caught her interest and ultimately established her desire to pursue

engineering. Rachelle's involvement in NSBE introduced her to another cultural capital

agent, who got her involved in STEM PREP and continued to be her cultural capital

agent through college. Rachelle shared this about her cultural capital agent:

> The program director of NSBE Pre College Initiative here on campus
>
> helped me. And the reason why I say her is because she kinda pushes me
>
> out of my comfort zone. So if I say that I am interested in something,
>
> most the time I will say I am interested in it, but won't really follow
>
> through. I kind of half-heartedly do stuff, but won't completely do it.
>
> But, she pushes me and tells me just go for it! Then she asks, 'Did you
>
> turn it in? Did you turn it in? Did you turn it in?

This cultural capital agent held Rachelle accountable and made sure to keep in

touch with her so that she would follow through and turn in her STEM PREP application.

In addition, she helped Rachelle select a career during her freshman year. Rachelle

continued:

> She also helped me come to the conclusion that I wanted to do chemical
>
> engineering. And that was during my freshman year. She got me
>
> involved in [STEM PREP], because she works up there with the program
>
> coordinator. She also knew what [the program coordinator] was doing and
>
> she gave me the application and she told me to fill it out. I met her before

I started [at the university] at NSBE. And she works here on campus, so

she knows the inner workings. She would send me to talk to people who

could answer my questions.

Rachelle explained how it was helpful for her to be in contact with her cultural

capital agent who knew how the systems within the institution worked. This person also

connected her with other faculty who could answer her specific questions. Rachelle's

cultural capital agent is an example of a knowledgeable culture capital agent who helped

her to increase both her cultural and social capital (Bourdieu, 1986). This is especially

important for first generation, underrepresented minority students.

Victoria, a first generation student, shared how her cultural capital agent was her

7th grade science teacher who advocated for her to participate in a summer STEM

preparation program for middle school students at a local university:

One of my science teachers was talking about a summer preparation

program for middle school students in class. He encouraged me and some

others to really apply to it and so I did. And I think he even submitted the

form. That program was geared towards STEM programs. And I think

just since then I got it in my head to do that. I think it really comes down

to that teacher. He really encouraged us. If it hadn't been for that I don't

know where I would have ended up.

Now, as she looked back on her experiences, she realized that the extra instruction

in math and science that she gained during three summers of STEM camp helped her to

get ahead academically, to become a National Hispanic Merit Scholar, introduced her to

STEM fields, and ultimately influenced her to pursue engineering. Victoria's situation

differed from Carlos and Rachelle in that she gained academic enrichment for three consecutive years:

So I would go over there for three summers starting after my seventh

grade year and basically it was like STEM PREP; it had computer science,

math class, English class and we got presenters every day from different

fields of engineering, science, and math. It supplemented my education.

It was a really good program. So I felt okay at math at the high school

level.

Victoria was able to experience this because her science teacher in 7th grade made her aware of the opportunity, suggested that she participate, and helped her with the application process. Without this cultural capital agent she may not have been exposed to the sciences along with academic enrichment, in the same manner, during her secondary education. Victoria's extensive exposure, three years of summer camp, really helped her to be successful and ultimately equated to an economic gain for her, a full scholarship (National Hispanic Merit Scholar Program).

Manuel was different from the others in that he did not identify a mentor or cultural capital agent in middle to high school. He was a first generation student who attended a rural high school that he described as low performing. He explained how he independently selected electrical engineering as a career during his senior year of high school:

I knew I had to do something with technology. I was really good at math

so I knew I should probably do something like that. Something that would

get me a good paycheck. Something that would make a difference is what

I wanted to do. I wanted my major to be challenging for me because I

knew high school wasn't. I knew engineering would be challenging. And

then I was throwing around what kind of engineering in my senior year.

And I chose electrical because my dad's an electrician. So I threw the

word electrical in with engineering. Also I think in high school one day

they took us to a website and told us these are the majors that will be

wanted in 10 years and electrical engineering was one of the highest. So I

kind of put that together with other things and just chose electrical

engineering.

Manuel was a self-motivated student and knew that he wanted and required more

of a challenge than what he was exposed to in high school. He used the resources

available to him, coupled with his self-awareness to come to the decision to pursue the

challenge of electrical engineering.

Gender - Impact for Female Students

In this analysis of data, I did not observe a strong relationship between gender and

the lack of cultural capital. It did not rise to the level of the three identified contexts:

socioeconomic status, first generation status, and academic under-preparation.

However, being that all participants were working towards engineering degrees, a

field that is underrepresented by women, I am including a look at the impact for female

students. While women earn the majority of bachelor's, master's, and doctoral degrees

awarded in psychology, biological sciences, and social sciences, they are less well

represented in computer sciences and engineering (Marrett, 2011). This being the case, it

is important to explore how female students become interested in pursuing engineering, a traditionally male dominated field.

All female participants reported having a cultural capital agent/mentor. Specifically for female students, their cultural capital agent was generally a science teacher in middle school (Grades 6-8). Most of the male students in the study reported that no one really pushed them towards a STEM field. They may have had teachers nudge them towards science, but they did not report being directly told a field of study. The male students were able to independently come to the decision without feeling like they were going against cultural norms. However, for the female students it was important that they have someone support them in entering engineering. It was not until after a teacher who believed in them encouraged them or after they were exposed to the STEM career (usually by someone with a STEM degree), that they decided to pursue engineering. With this support it became possible for each of them to forge a path for underrepresented women in the field of engineering.

Three years of participation in summer STEM camp helped to prepare Victoria academically and exposed her to engineering fields early, which influenced her later to pursue civil engineering. Learning about the profession early in her secondary education allowed her to ensure she took the necessary math and advanced math classes in high school. This makes it important to recruit female students to engineering at an early development (adolescent identity formation) age and mentor them towards these fields of study.

For Carly, whose father was a strong advocate for STEM, it also helped her to have a teacher who reinforced this and reaffirmed that she was good at math. She discussed another mentor for her:

Also my junior year math teacher. She really helped me like math and understand it. And she also told me don't do teaching, do engineering instead. She said, 'You're really good at math and you need to do something with it'. I think she really helped me decide what to do and what to focus on.

In addition, her physics teacher exposed her to the STEM PREP, which was an academic enrichment opportunity: "My physics teacher at high school really pushed for me to do STEM PREP. He would hold engineering program meetings and he had us go to engineering meetings at [the university] for extra credit." Carly's familial cultural capital along with other cultural capital agents (teachers) really helped to reinforce her decision to purse engineering. Her cultural capital agents exposed her to the STEM PREP opportunity augmenting her father's support.

In the same manner, Mari's mother, who worked with engineers, helped to influence her daughter to consider engineering. Mari was able to attend a private high school that focused on STEM and provided students with a solid math and science foundation. Mari's teachers provided her with exposure to academic enrichment opportunities as well as engineering related summer programs. With all of this exposure, Mari knew before she arrived at the university that she wanted to pursue civil engineering.

Both Victoria and Rachelle benefitted greatly from their middle school science teachers who exposed them to STEM enrichment programs. Victoria had extensive exposure to a summer STEM camp. For Rachelle it was important for her to be involved in NSBE outside of her school to maintain her interest in school and in STEM. This allowed her to meet the Pre College Initiative (PCI) director, who ultimately influenced her to apply to the STEM PREP program and choose chemical engineering as her major.

Jasmine's path was a little different from the other female students. She found herself in an identity crisis (Erikson, 1980) during her adolescent years. She looked around her community on the reservation and she could not identify with the status quo. Her identity crisis caused her to think about what she wanted to do with her life. From there she launched a bold plan to move away from her parents to another state and finish high school at a better school. Fortunately, she was able to move in with her brother and his wife, giving her access to a high performing, urban school and got her closer to pursuing her dreams. She shared some of her thoughts and emotions related to her identity:

> As a pre-teen I was very, very unsure of myself. I wanted all these things
> but I didn't have the self-esteem to do it. Right now my self-esteem is
> stronger than ever. Before I had to move I was thinking about what I
> would do with my life. I thought about the area I was in. Not very many
> people leave the area. They don't get out, they don't explore. They just
> stay in that little, rural area of [the state]. When I thought about that I just
> thought why am I here if I want to do all these things? I think that was the

main drive that I had. And with that I guess my self-esteem just went

up… Considering that I could do more.

After enacting her plan to move and start at a new high school, Jasmine's self-

esteem progressively flourished. While at the new high school, she met several teachers

who functioned as cultural capital agents for her. She shared a little about her physics

teacher who was a mentor to her:

> With [teacher], she went to [state technical college] and she was a
>
> chemical engineer so I would talk to her about the major and she was very
>
> helpful to talk about her experiences. She reinforced my interests. I was
>
> lucky for that. I thought she was just teaching physics, but she got her
>
> degree in chemical engineering!

Also at Jasmine's new school there was a much greater focus on college

preparation and career selection than at her previous high school. She shared how

presenters from the local university would come to her new high school:

> People would come over and present and talk to us and they would give us
>
> insight into how the schools worked in law, business, pre-medical and
>
> they would talk to us. One of the people from the school of engineering
>
> team came and it just seemed very interesting. After he came, I went
>
> online and looked at the program. So I decided to come here based on
>
> how well their engineering was placed nationally and internationally. I
>
> found that there was a lot of diversity here. I just felt it would be better for
>
> my needs.

Jasmine was highly influenced by the presentation and it helped her to both select her university as well as her field of study. This combined with the influence of her cultural capital agent helped her to narrow her focus to chemical engineering before she arrived at STEM PREP.

For the female participants in the study it was important that someone supported their desire to earn a STEM degree. It was also critical to interact with role models in STEM fields prior to them deciding to select their career. This was something that was not reported as a requirement for the male students. For the most part, the male participants were independent and self-assured in their career selection.

Cultural Capital Agent Support in college

For the five female students it was also important that they had a cultural capital agent during their first few years of college as well. Four of them reported that the program coordinator of the STEM PREP played an important role for them by answering their questions and mentoring them in their first two years of college. Shared below are quotes from the female students relating to the support they received from the STEM PREP program coordinator. Victoria shared:

> I met [the program coordinator] and I just always knew I had him to go to
> if I had any questions. For me there wasn't one other person like [the
> program coordinator] here in my first two years. Now I have met [other
> faculty] who I could go to if I needed guidance, but that is more recent.

For Victoria, having the program coordinator as her mentor in the first two years gave her the peace of mind that there was someone there to support her. Mari, who did

not qualify for financial aid or the lottery scholarship, was able to get a stipend through the program coordinator to help her with college expenses:

> Once I started going to school here [the program coordinator] found a research assistantship for me. I was able to get a stipend and that really helped me a lot.

Carly shared her perspective on having the program coordinator as a cultural capital agent:

> [The program coordinator] was very helpful in answering any questions we had. He also gave you a safety net. If something went wrong with your classes you could always go to him and he would understand what you were going through. I think that was really helpful.

Carly echoed the sentiments of Victoria and used the analogy of having a safety net of support to describe the program coordinator's role for her.

She told me, "It is easy to go and see [the program coordinator]. I constantly go and talk to him about my classes." The program coordinator's proactive guidance of students and his willingness to extend himself and be available to help students provided them with a degree of agency that allowed them to overcome a lack of cultural capital and develop their independence over time. The interaction they described illustrated how he helped them to navigate the College of Engineering, become more academically involved at the institution, and utilize college services that were designed to help them persist. Students attach significance to being able to navigate the college environment on their own, which reflects the development of independence and autonomy (Yazedjian et al., 2008). It should be noted that students with high cultural and social capital have

access to networks of relatives and other experienced individuals who help to direct them through the college navigation process. The college students with low cultural and social capital have to rely on others, generally at the institution, to help them develop personal agency. In this manner the STEM PREP program coordinator developed opportunities to foster collaboration as well as promote student engagement and personal development, which impacts persistence for underrepresented minority students.

For Rachelle, the African American participant in this study, it was very important for her to have a mentor of the same ethnicity and to see other African Americans demonstrate success in STEM studies and careers. This was somewhat more difficult since African Americans were the most underrepresented minority at the university. She expressed the most ethnic isolation within Engineering Student Services (ESS). For example, she shared:

There are a lot of minorities in ESS because [this state] has a large

Hispanic population, but there are not a lot of African Americans up there

and not a lot of African American females. So it's hard. You are coming

in especially as a freshman to a university and you just feel so

overwhelmed. And you are timid, just trying to test the waters. You don't

really know what is going on and I feel like I was shoved to the side a

little bit my freshman year.

Even after having participated in the STEM PREP program when she arrived on campus in the Fall and had declared her major as engineering, she was placed in a University Studies (general) orientation and they advised her to take liberal arts classes, not the math and science classes she needed for engineering. She was confused, but

knew it did not match her focus so she sought out advisement from ESS. When she

arrived there, she reported that she was misadvised and told to take the wrong chemistry

class. This scenario can be very confusing to a first generation student who feels ethnic

isolation. Eventually Rachelle asked some of her STEM PREP peers who were a more

reliable source than advisement and they were able to provide her with the correct

information.

For participants of other ethnicities, they addressed any feelings of ethnic

isolation by living and studying with other students of the same ethnicity. At this

university, this was possible for students of other ethnicities, but much more difficult for

the African American student as there are about 2.9% African American students

enrolled at the main campus and even fewer within the college of engineering.

Fortunately for Rachelle, she had met her cultural capital agent, who was an African

American woman working in a STEM field when she was in middle school. She met her

cultural capital agent through her local chapter of National Society of Black Engineers

(NSBE). For Rachelle it was important to see black women working in the field of

science to feel that it was possible for her. Her participation in NSBE introduced her to

another cultural capital agent who was an African American woman who worked in

Engineering Student Services at the university. This connection helped her to continue to

have an interest in STEM throughout high school and put her in touch with the STEM

PREP program.

Of the five male students only one recognized the program coordinator as a

cultural capital agent. For Carlos, the program coordinator was of utmost importance

because without him, he would not have enrolled in college that semester (right out of high school). He shared how the program coordinator has continued to support him:

> [The program coordinator] helped me a lot. I keep in touch with him. I always drop by. For the first two years he has helped me check my classes and what I needed to take. He would tell me to take this class in the summer to help me catch up. He helps me to navigate through the system. He is really the only one.

First generation students and females needed to maintain contact with the program coordinator for the first two years at the university. For those students who did maintain contact with the program coordinator, they also learned about research opportunities that they pursued. These opportunities increased their academic integration and simultaneously introduced them to additional engineering faculty, extending their academic network.

Impact of Academic Under-preparation

A student's socioeconomic status affects their access to high quality primary and secondary education. Students who do not have access to high quality K-12 education often find themselves under-prepared academically to participate in higher education and persist towards a degree. Students who complete high level mathematics courses (trigonometry, pre-calculus, calculus) are more than twice as likely to graduate from college as compared to their peers who completed basic mathematics (pre-algebra, algebra) (Adelman, 2006; Conley, 2008). Anyon (1995) suggested that public schools in complex industrial societies, like that of the United States, make different types of educational experiences available to different social classes; for example, providing

vocational education to low socioeconomic students and reserving highly competitive selective academic university admissions for society's most affluent students. In line with Anyon's (1995) finding, participants from a lower socioeconomic status reported having less access to higher level Advanced Placement classes, honors classes, and/or advanced math courses at their public high schools. One of the STEM PREP faculty astutely shared her perspective on students who she had to taught, "The students who went to the more well-funded schools did better. There was an economic divide."

The STEM PREP math faculty pointed out how they are tasked to instruct a group of students who come with varying levels of math preparation, "ranging from some who were calculus ready to some who were not even algebra ready… we are talking fractions." This faculty member added, "my role as a math teacher was to evaluate their abilities coming out of high school and then teach to deficiencies as I saw them, for the whole class." This faculty member noted that students who arrived from urban high schools generally had the tools to be successful in math, but those who came from more rural areas had more math deficiencies. To help address math under-preparation in high school and academic rigor the STEM PREP math class was designed to successfully transition students from high school math to college level math courses. "The math class was rigorous. I was not easy on them. I mean there was a lot of work." The faculty member shared his perspective that most high school students were not accustomed to putting in long hours of math homework and hence STEM PREP was designed to help them make the shift. In this manner, STEM PREP also helped students with developing college study skills and habits. STEM PREP faculty concurred that math was a barrier for students pursuing STEM fields. One faculty member highlighted the following:

One of the biggest problems I felt that they had was bad habits and non-organization, which in any college major is important. But mostly important, in my perspective, in mathematical fields. In the program they had tutoring sessions every night. They knew they had to do homework in front of us every night. We tried to develop for them the habit of keeping up with homework and preparing for exams because we gave them exams every week.

She shared how the STEM PREP tutoring sessions were designed to help students develop the organizational skills, study skills, and homework habits necessary to be successful in college.

STEM PREP and Placement Exam

Students that received subpar math preparation in high school have an opportunity to address math deficiencies during the STEM PREP program and take a placement exam that will override their original placement based on their ACT score. Fifty-percent of the participants in this study placed into college level calculus (I or II). Thirty-percent placed into algebra II or trigonometry and 20% placed into developmental level math or pre-algebra. After the four weeks of STEM PREP classes, students completed the COMPASS placement exam. Two students benefitted from this, Marco and Carlos. They were both able to place into a higher level math class than the one where their ACT had placed them. In addition Marco, an English language learner, was also able to place into college level English. Carlos, on the other hand, had not taken a math class for two years and the algebra II class he completed in high school was subpar. After the STEM PREP program, he was able to place into algebra II and he reported that he was much

more comfortable with his math abilities. Marco had taken mathematics up to pre-calculus at his high school in Mexico. After completing the STEM PREP program, he was able to place into college level calculus I and English 101. This translated into a cost savings for the students as they spent less time in "make up" classes, which can lengthen one's college career. For the 30% of students who had placed into algebra II or trigonometry, they had two to three math classes to complete before they could begin calculus and start checking off their math classes on their engineering curriculum tracking sheet.

Remedial Math Classes

The students who were the most shocked about their math placement were the two who placed into developmental math class, pre-algebra. Both Rachelle and Andres had completed algebra II in high school and had received passing grades, but arrived at college with math deficiencies that could not be addressed in the four week STEM PREP. They were both very disappointed that they had to "repeat" math classes. The students attributed this to the poor math classes that they completed in high school. Andres and Rachelle had to complete five math classes before they could take calculus I. They were not able to double up in a semester so in essence they spent the first two years (including summer semesters) of college getting to calculus I. Although Andres recognized the great disadvantage he experienced, after having completed the math classes and having a phenomenal math teacher, he reported that it was "the best thing that happened" to him. If had he not met this incredibly, supportive math teacher, his story may not have turned out for the best. With her early support, extra tutoring, and belief in him, he was able to

complete the entire developmental track of math classes and has since passed calculus I, II, differential equations, and statistics.

Rachelle shared how her math deficiencies and her personal medical history and family medical history had set her back. She took her math classes in the first two years. "So I am a sophomore in the chemical engineering department, but I am a fifth year senior." While she has been enrolled full time for five years, she had only enough engineering credits to qualify as a sophomore in chemical engineering. Rachelle estimates that she has two more years of college for a total of seven years. Her situation illustrates how far under-preparation in high school can set a student back. Even though she had many tough classes to complete in the next two years she shared her thoughts on how she keeps persisting:

> I am the type of person that once my mind is made up, it is made up.
> Whether in the process it makes me miserable, whether I have ups and
> downs, my mind is made up. So I came in not really knowing either
> biology or something in the engineering department. I thought, I'll do
> chemical engineering from day one. From day one, once I decided
> chemical engineering, I have not changed my mind since.

Her testimony demonstrates the high degree of determination that a student needs to stick to their goal after five years of college.

When students arrive at college and find themselves underprepared in math, it is essential that they seek out the student support services, such as tutoring, that are necessary to succeed in mathematics. Treisman (1992) found that many minority students, especially Black and Latino students, did not use these student support services

that were designed to help them. Rachelle, an African American student, shared how

when she arrived at college she did not seek out tutoring, even when she was in a

remedial math course. She mistakenly thought that she had to prove she could be

successful on her own. Some of this mindset may have been because she had little to no

support in high school:

> When I first got to college it seemed like such a big thing. You want to be
>
> able to take it on by yourself and show people that you can do it without
>
> anyone's help. But, I realized you don't actually want to struggle. I have
>
> learned that [tutoring] is a great place to go. I am there now pretty much
>
> every day and I even go to afterhours in the student building.

STEM PREP stressed the importance of tutoring and study group sessions to help

underrepresented minority students better transition to college. The program positively

modeled study sessions for them and as a result they were all more likely to pursue

tutoring, when needed. Most of the participants in the study utilized the student tutoring

services in their first semester, unless they themselves were a tutor, as is the case with

Ernesto and Carly. It is important to note that sometimes African American and Latino

students might not seek out tutoring even after being introduced to the service (Treisman,

1992). Once Rachelle embraced the support of tutoring, she was able to make headway

in her math classes. She completed the entire developmental math track and had since

passed, calculus I, II and III. She still needs to complete differential equations.

It appears that the remedial math classes at the university were instrumental in preparing

both Rachelle and Andres for their advanced level engineering math course requirements.

It is clear that by placing into the developmental math track at the university, they were

burdened with taking five additional math classes, which greatly extended their time enrolled in college. Both of these students have not yet graduated or completed their degree so it is not yet possible to say how the remedial classes impacted their ability to graduate.

High Impact Socio-academic Integration Increases Persistence

Research suggests that persistence in college is related to a student's ability to build academic and social interactions within their institutions (Braxton, 2000; E. T. Pascarella & Terenzini, 2005; Tinto, 1996). The participants in this study reported that high impact socio-academic integration played a key role in their persistence. The three most important activities that they listed as increasing their socio-academic integration included:

1. The STEM PREP program;

2. Socio-academic integration (Peers): peer study groups, membership in student engineering organization, leadership in a student organization;

3. Research assistant (Faculty Integration) – working with faculty on research projects.

STEM PREP

I set out to learn how underrepresented minority students persist in a STEM program. As a part of this study, I examined how the STEM PREP helped students successfully transition to college. In the words of the students, "It was really a crash course for what college would be like"; meaning the program itself helped students transition to higher expectations of college.

A key finding was that the STEM PREP program was successful at developing socio-academic integration for students. All participants (students and faculty) reported that the program's most successful aspects were related to developing socio-academic integration or rich, academic interactions that connected them to people in their program and the institution. STEM PREP helped them in these important ways:

- Providing math and English content that prepared them for college;

- Building a socio-academic network with peers, faculty, and student support services;

- Exposing them to STEM career presentations in multiple departments which allowed them to select a career with which they most identified.

STEM PREP Math and English Classes

Most students reported that the math review of content was very helpful. They shared similar comments, for example: "The math and English class was really helpful, it was like a refresher." The students who predominantly emphasized the importance of the math and English content were Marco and Carlos who placed into high level classes as a result of the STEM PREP program and their final placement exam.

Marco shared his perspective on how STEM PREP helped him for both math and English, but really gave him the boost he needed for English:

> The [STEM PREP] math and English classes helped a lot. Math was one
> level up from what I had [at American high school] so it really helped
> bring me back into shape. For me [STEM PREP] really hit the nail on the
> head for my English. Because I lived on campus and I didn't interact with
> my family, I had to speak English if I wanted to eat and do some basic

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stuff. So the biggest transition was to fully get my English skills down

and [STEM PREP] helped a lot.

Carlos shared how the math and English classes helped him brush up on the content, but more importantly he shared how STEM PREP caught his attention and changed his mind set:

During the program we had to take English and math. I started focusing on math a lot. At the time my thought process just switched. You are 18, you are not a kid anymore. You are not in high school anymore. You don't blow this off and go hang out with a friend. This is serious. I started focusing a lot on math. I think that is why I placed higher. It actually helped me realize how college is. It is not the same as high school.

For Carlos getting exposed to college shifted his identity from a "kid" to an independent college student. Taking into consideration the ideas that "students' engagement in school – their choices, struggles, and negotiations is clearly affected by, and in turn influences, who they think they are, who they think they want to be, and who they actually become" (Kaplan & Flum, 2009, p. 76), it is important to consider identity development. Being among peers who aspired to study STEM and the high expectations of the STEM PREP faculty caught his attention and provided him with the opportunity and space to rethink his identity and to choose his future path. This shift of recognizing his past choices and now for the first time thinking about his future helped him to work on his identity development. Once he established who he wanted to be, he was able to focus on his academics and he placed into a higher college level math class. For the

students who had deficiencies in math or English due to under-preparation in high school, they reported that STEM PREP helped them transition to college by helping them catch up on some of the content.

STEM PREP Career Presentations

While many of the students knew they wanted to pursue a STEM field of study, many of the female students had not necessarily singled out a career. Participants reported that one of the most helpful parts of STEM PREP was related to the career presentations by STEM faculty and tours that they took of each STEM area. If they did not already have a selected career, this helped them narrow their focus and select a career before they began college. If they had already selected a career, the presentations helped to affirm their decision. Rachelle explained:

> They helped me open my eyes to different fields and how I am able to
> apply myself. I knew there was mechanical engineering, civil, electrical,
> but I didn't know what those engineers did. They took us to each
> department and they demonstrated what they did. It helped me with my
> decision factor. It helped me to clarify what I wanted to do, chemical
> engineering.

For Victoria the career presentations by faculty helped her to narrow her career choices. She considered the faculty presenter to be a strong female role model:

> She [faculty member] came in and talked about the different aspects of
> engineering and I remember her saying that she found construction
> management to be the most fulfilling thing she had done. So I did a little
> research on it and found the pay was just as good. So I chose construction

management my first semester. It just sounded like something that I

always wanted to do.

Carly likewise was able to select a career based on the presentations:

The career tours really help me. Tours of the different engineering

programs, even physics, and chemistry. I knew I wanted to do

engineering and I was just going to do basic or general engineering

because I didn't really know what each entailed. I chose civil because the

presentation that they gave us was like you can do so many different

things and they are very helpful to the community. And that's what I

wanted to do.

Upon arrival at the STEM PREP program, participants knew that they had an

interest in a STEM program of study. Not all of them had a field of study narrowed

down at this point. Their exposure to the faculty from multiple disciplines, presentations,

and tours helped most of them to solidify their major. Knowing one's major before

beginning college can help students to focus on a goal and can reduce the amount of time

spent in college.

Building a Socio-academic Network

Building relationships with faculty and peers can provide first generation students

with the cultural and social capital to strengthen academic knowledge and lend

encouragement and needed information about cognitive, behavior, and procedural

strategies for success in college and career (Deil-Amen, 2011). In this study, all

participants reported the benefits of building relationships with faculty, peers, and student

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support services (predominantly tutoring) as a means of persisting and remaining successful in college.

Manuel shared his perspective on what he found most helpful about STEM PREP, "What was great is that you go into the fall semester knowing 23 people." He, like others, recognized the importance having a network of peers and faculty who you know when fall semester starts. The students shared the following perspectives on networking and how STEM PREP really helped them to establish socio-academic integration:

I think the biggest is just the multiple people you get introduced to. Plus you meet more people who are in the same studies that you want to do in the engineering program. A bigger network, I would say. – Carly

[STEM PREP] helped with networking. It helped me to build early connections with people who are here and in the same degree fields. I still have good friends from [STEM PREP]. You know it is good to have those early connections. – Ernesto

Networking, the network I built up [through STEM PREP] made the whole difference. The fact that I was living on campus I got to interact with peers and interact with the whole university. – Marco

In addition Mari shared, "The [STEM PREP] program really helps you network and connect with people." All of these participants valued that the STEM PREP program helped to integrate them at the university and introduced them to a network of peers and faculty who they continued to work with to be successful during their college experience.

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Socio-academic Integration

Students who are engaged in academic discourse and activities with their peers and faculty are more likely to persist if they become integrated into the institution along two dimensions, academic and social (Tinto, 1996). Participants in this study reported that socio-academic integration was essential for their persistence in college and for their future career as well. The most beneficial socio-academic activities reported included peer study groups, engagement in a student organization, having a leadership role within a student organization, and research assistantships.

Manuel described how his involvement in a student organization immersed him in his college experiment and developed his social capital:

Getting involved was an important thing for me. When you are involved with something on campus then you are immersed a little bit more in the University and whatever program you are in. As well as the other benefits you get like the people you meet, people who give you tips, that kind of thing.

Manuel was a first generation student, who by the end of his third year in engineering, had adeptly developed his cultural and social capital and leveraged it. Manuel joined the Hispanic engineering student group. After two years of participation, he was elected as the group's President and completed a successful year of leadership (during his Junior year). He later found that this leadership role helped to get him an internship at Toyota:

I went to a career fair here and talked to a representative from Toyota. They looked at my resume and said, 'Oh, you're president of the Hispanic

Engineering and Science Organization. That's great. We'll get you an

interview.' And they gave me an offer a couple of weeks later.

While at Toyota, Daniel's supervisor shared some career advice with him:

One thing my supervisor told me at Toyota was, 'your good GPA actually

put you in a pile of resumes with good GPAs. Sometimes they are not just

looking for high GPA, what they are looking for is what makes you

interesting. Stuff like board positions, community service, leadership

roles that kind of thing. So the more stuff you have like that on you

resume the better chance you have of getting hired. It's not all just

grades.'

Daniel agreed with this advice and he found himself mentoring other students and

sharing with them that they should get involved with student organizations and take on a

board position. He wholeheartedly felt as though this helped to get him immersed in

college and in turn become a more active, successful student.

Peer Study Groups as Socio-academic Integration

The participants in this study relied on peer study groups to help them complete

homework, avoid struggling in isolation, and to learn new content collaboratively.

Participants shared how they were highly encouraged in STEM PREP to form study

groups and how they attributed the study groups to their persistence and academic

success. The ways in which they chose to implement study groups varied based on their

individual needs. Some students preferred to study with only a peer, while others studied

in groups as large as eight. The impact of the study groups was that students maintained

their socio-academic integration while learning collaboratively. Rachelle shared:

During [STEM PREP] we had to do a lot of group work and because I was

in the same dorms as my group, we could just meet downstairs in the

commons area and hash it out. I decided then that I was going to live in

the dorms. When it comes to meeting and doing study sessions, it is nice

to be right there on campus. So you don't have to commute back and

forth. And that sense of community, being with other people that have

your same interests.

For Rachelle, the study groups that she participated in during the STEM PREP

program helped to develop a sense of community, which allows her to feel that she

belonged at the institution. Her STEM PREP experience influenced her decision to live

on campus in the dorms.

Students shared information about the types of study groups they formed:

The chemical engineering program is not a big department. So you really

get to know the people taking classes with you. We formed a group of

five students who always did our homework together. It was a supportive

group. We worked long hours doing homework and the company was

very, very helpful. – Marco

For Marco, a group of five students within the chemical engineering program is

what worked.

Andres shared how his study group increased his individual brain power:

Study groups. I think it is good to have people that you can get together

and study with. That way you can talk about stuff with each other, you

just have more brain power. I have a lot of good friends that I study with

and we kind of push each other.

For Andres, his friends in his study group held him accountable and pushed him

to succeed.

We always have study groups and we try to help each other out. We are

practically going to be family by the end when we graduate. We always

see each other. We practically have every class together. It is kind of a

large group of eight. My study groups are cool. We get our stuff done,

but we also joke around while we are working. – Carlos

These quotes illustrate different types of study groups based on the individual's

preference. One student, Ernesto, avoided study groups (3 or more students) and opted

for studying with a peer:

I don't do a lot of study groups. Usually it is just me and someone else.

Peer study, not a lot of group study. The fact is classes are tough. It helps

to study with a peer, rather than study on your own.

Carly, who was also a tutor, shared how she prepared and studied before the study

group so that she could help others:

[STEM PREP] really helps you form study groups. Sometimes I study

before the study group. People love to ask me questions because I read, I

take notes. People always want me to explain thing to them. So I want to

keep on top of it to help them.

Rather than being competitive with peers in their classes, students were collaborative and studied together. They recognized that this helped them to be successful.

Faculty Socio-academic Integration

Students articulated that their interactions with teachers or faculty were more pivotal for cultural and social capital transmission than their exchanges with advisors and counselors (Deil-Amen, 2011). Similarly, in this study, the participants did not rely on advisement in the first few years, as they had experienced many situations of misinformation from advisors. Instead, in the first few years they relied on the STEM PREP coordinator and/or their peers. The coordinator made himself available to participants and was very responsive to their needs, providing information on classes, credits, and STEM. They shared the specific ways in which the program coordinator for STEM PREP helped to advise them by linking them to other faculty, providing them with valuable information about additional financial aid and/or important research assistantships, and ultimately improving their socio-academic integration and persistence. Other students relied on upper classmen in their field of study to provide them with advisement.

As participants advanced into their third year of engineering (or 300 level classes), they began to interact more with non-STEM PREP faculty members who were within their program of study. But, it wasn't until their higher level, degree-specific courses that they experienced faculty with a willingness to engage in academic discussion and integration. Since faculty can be a primary source of cultural capital, both in and out of the classroom, as they transmit valuable information to students (Yazedjian et al.,

2008), this type of faculty interaction is very important especially in the absence of a STEM PREP type program. Without the support of the STEM PREP program coordinator, many students would have experienced navigating college on their own during their early college years and may have not received the support they required to persist.

Due to Mari's extensive interactions with the Summer Transportation camp (two summers) and the STEM PREP program (one summer), she had established early faculty relations and she felt that she could approach the faculty she had met in both programs as they were very willing to take the time to meet with her. In fact, she made it a habit to visit faculty she knew before each semester started as a means of maintaining her rapport with them. It is clear that for underrepresented minority students in STEM fields of study it is important for them to meet and interact with faculty in their first year of college through programs like the summer transportation camp and STEM PREP. Ernesto shared his perspective:

> I have faculty that I am closer to because of [STEM PREP]. Whenever I was being advised on classes I needed to take I would always try to get faculty from the [STEM PREP] because they keep close ties with the students.

Ernesto's comment related to the fact that he got more accurate information from the STEM PREP coordinator than from engineering advisors and that STEM PREP faculty exhibited behavior that was more welcoming to students than their faculty members who were teaching large, introductory gateway courses. For Mari, she knew that the STEM PREP and faculty from her transportation camp had a vested interest in

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supporting her as a Native American female who was pursuing civil engineering. She

valued and continued to foster these faculty relationships as a means of staying connected

to the institution and its programs.

Research Assistantships

One of the most important activities related to socio-academic integration was

when students participated in a research assistantship in which they worked in a lab for a

STEM faculty member conducting research. Four of the ten participants reported that

they had completed a research assistantship. All of them were first generation students

and had learned about the opportunity from the STEM PREP program coordinator. In all

of the cases, the research opportunity improved their socio-academic integration and

motivated them towards their careers. The assistantships allowed them to get a taste for

the type of work experiments they would be doing in the future while applying what they

had learned in the coursework. Here are examples of what students said about

completing a research assistantship:

> The program coordinator got me into his research assistantship program.
>
> And I think that really helped because it put me in contact with two more
>
> faculty members who I could go to. And I think it really helped my
>
> resume. And it probably helped me to get this internship. –Victoria

Victoria attributed her assistantship to helping her obtain a summer internship

with federal highways working on construction and highway planning in Montana.

> I have been working in research labs since my sophomore year, so I kept a
>
> close relationship with professors in my specific field. And I worked in

different labs. I changed because I wanted to try different research areas so I got to experience different personalities in the professorship. –Marco

Marco adeptly tried out different research assistantship while in his undergraduate program. He now works in a lab conducting semiconductor research for his PhD.

[The program coordinator] called me and said he had funding to get students involved in research. And I said that would be perfect. So he had me contact the professor who works with semiconductors. So I started getting involved and learning. And that sort of narrowed my focus. And it wasn't until that research, thanks to [the program coordinator] that my focus was set to semiconductors and materials. –Carlos

Carlos' experience helped him to narrow his career focus within chemical engineering to semiconductors and materials. He has since made contacts at a semiconductor manufacturing company and has plans to apply for an internship.

Mari was able to get a research assistantship with a stipend, which helped her to cover about 80% of her tuition that semester: "[The program coordinator] found a research assistant job for me here. And I was able to get a $2,500 stipend that helped me a lot."

All of the students who reported completing a research assistantship were first generation students who greatly benefited from the opportunity and who may not have sought the opportunity out on their own.

In addition, Jasmine conducted a course on independent research and presented her results. Victoria and Manuel reported completing internships (in their junior year), which provided them direct exposure to the working world. Two students had part-time

jobs in their field: Carly worked at the national laboratory and Andres worked for the city planning department completing CAD (computer-aided design) work. All of these opportunities (research assistantship, internships, and part-time jobs within their field of study) were reported to motivate the students toward degree completion and reinforced their decisions relating to their career selection. It is clear that these high impact socio-academic opportunities helped underrepresented minority students to apply knowledge in a relevant work situation and engaged them in their field of study. Institutions, in addition to providing student support services, should also promote a combination of student engagement and personal development as important components of college success. In addition, providing research opportunities for underrepresented minority students in STEM could improve student engagement and retention while preparing them for a STEM career. By offering transition programs, cultural capital mentors, and academic and social support for underrepresented minorities and underprepared students we can begin to improve retention and degree completion in STEM fields (Fenske et al., 2000; Kee, 2007; Slovacek et al., 2011) creating a more diverse workforce in science and engineering fields.

Conclusion

My research was guided by the following question: How do underrepresented minority students enrolled in a university's science, technology, engineering, or math program experience college success and persist towards degree completion? The analysis identified that participants from one of the noted contexts (low socioeconomic status, first generation status, and academic under-preparation) experienced barriers on their path to college and while enrolled in college. Many of these barriers existed due to lack of

cultural capital. Participants who fell within the intersection of two or three of these contexts reported that they experienced the most severe barriers; lack of financial support, major family health issues, personal health issues, as well as reconciling their personal identity with an identity of "not college material" placed on them by society. Initially they had accepted this social identity and it was not until they made the decision to go to college that they felt they began forming a new identity of college bound student, which replaced the societal identity. The students who reported addressing their identity development, by newly defining who they wanted to be seemingly developed their abilities to make new, independent choices and maneuver around existing barriers. These students shared that they would not have been able to do this without the support of people who believed in them and motivated them to negotiate these struggles (cultural capital agents) in order to attain their overarching goal of a better life. These cultural capital agents, who helped them, played an important role for these students in terms of enabling them to further develop their identity and had provided them with access to academic enrichment opportunities, which exposed them to STEM fields along with rich information on how to navigate complex education systems and institutions.

This chapter focused on the supports that underrepresented minorities, in this study, received that enabled them enroll in college, transition to college, and persist in a STEM field of study. The key supports have been outlined in Figure 7 and placed on a timeline to best illustrate when these supports were reported to be the most useful. The supports fell into two categories, pre-college support or college support.
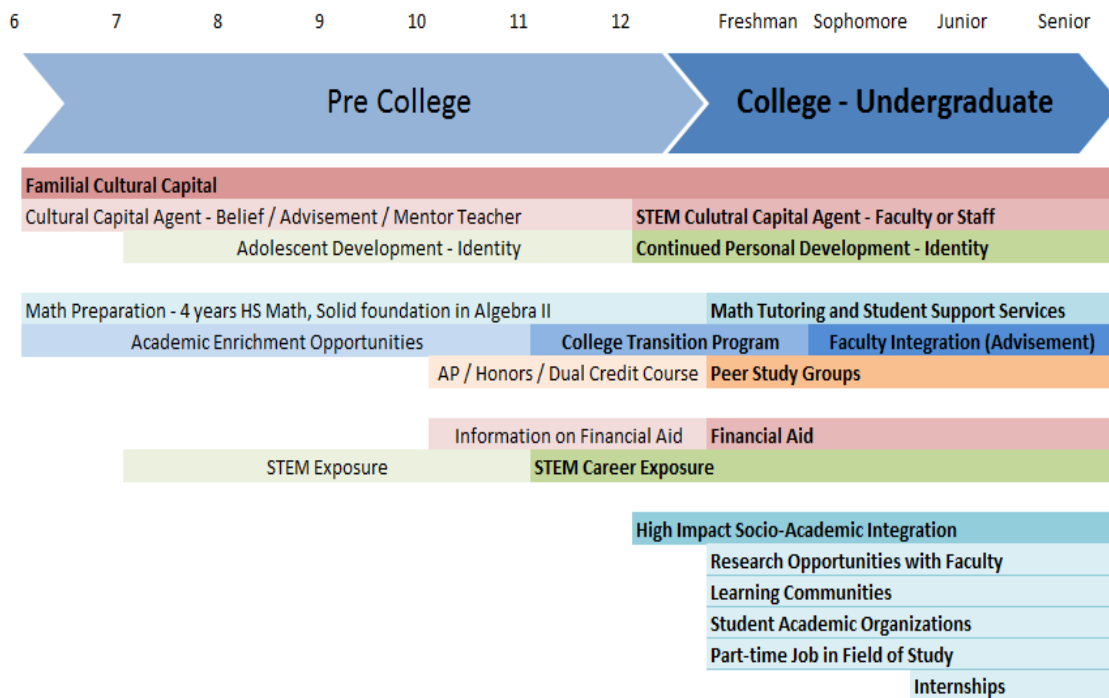
Figure 7. Key Supports that Enabled Persistence for Underrepresented Minority Students in STEM Programs.

While students from within the three contexts experienced distinct barriers, they highlighted the supports in Figure 7 that helped them to be successful and persist in the face of barriers. As a result of this research, it is clear that well-designed transition programs, like STEM PREP, play an integral role in developing cultural capital for underrepresented minority students. The beneficial program content coupled with cultural capital agent support, provided by the program coordinator and other STEM PREP faculty gave the students an essential boost that helped them transition. Students from higher socioeconomic status and those who arrive at college prepared generally have the academic skills and have accrued cultural capital that allows them to transition effectively without this type of targeted intervention. The STEM PREP program was critical for lower socioeconomic status students, underprepared students, and first

generation students pursuing STEM. This finding is congruent with the research finding

of the Institute for Higher Education Policy related to the NSF's Model for Institutions

for Excellence (MIE) Programs (Kee, 2007). The MIE programs were focused on

recruitment and retention of underrepresented minorities to STEM through providing

counseling and academic enrichment.

The key aspects of the STEM PREP program that enabled persistence were: 1)

identifying underrepresented minority students who wanted to pursue STEM; 2)

providing academic enrichment – a) addressing math deficiencies or under-preparation,

b) developing study skills and positive study habits, and c) setting rigorous academic

expectations; 3) enabling socio-academic integration and networking while developing

cultural capital; 4) providing accurate STEM advice and support; and 5) exposing

students to STEM career information delivered by faculty for better career selection or

career choice validation. All of these elements were integral to ensure early persistence

for students during their first two years of college. In most cases, participants were

creating their socio-academic engagement and making faculty connections on their own

in their third year of their STEM program.

For students to persist beyond the first two years, it was important that they

increased their engagement with faculty while maintaining their socio-academic

integration with peers in their field of study. This study identified that one important

method of achieving this for the STEM participants was through engagement in high

impact socio-academic activities. The types of activities that encouraged high impact

socio-academic engagement included: 1) the STEM PREP student transition program, 2)

Peer study groups, 3) active involvement in student academic organizations, 4) freshman

learning communities, 5) research assistantships that promoted faculty integration and career interests, 6) internships, and 7) part-time work (less than 20 hours/week) in career related jobs.

Conventional practices formulated from many years of educating traditional American college students are designed to serve students with high cultural capital (Grimes & David, 1999). My research found that low socioeconomic students can experience college persistence and success when they are provided with additional, targeted supports that help them to gain cultural capital as well as address academic deficiencies.

Chapter Five - Conclusion / Implications

This study explored the phenomenon of underrepresented minority students who successfully persisted in STEM fields of study beyond their first year of college. The findings highlighted the importance of cultural capital in relation to developing college-going behavior and persisting towards degree completion. The research explored the lived experiences of ten underrepresented minority students who enrolled in a STEM degree program and persisted beyond their first year of college, at a southwestern research university. Academic preparation was identified as an important factor related to persistence therefore, it was necessary to examine the participants' pre-college educational experiences. It was important to understand the factors that presented the barriers to attending college as well as persisting to degree completion. The three contexts that encompassed the greatest barriers for participants were: 1) lower socioeconomic status, 2) first generation student status, and 3) under-preparation in math. These contexts proved to be more important than the overarching category of underrepresented minority student, with low socioeconomic status being the context that placed students at the most disadvantage. Each context contributed distinct barriers to college success and issues were compounded if students fell into multiple contexts with one of them being lower socioeconomic status. This examination of participants' pre-college experience exposed how students from lower socioeconomic status did not have access to high performing high schools, hence they were not as academically prepared unless they had encountered the support of cultural capital agent(s) in secondary school.

The purpose of this study was to discover how underrepresented minority students entered and persisted in STEM degree programs. This is important, not only as a means

to provide equal access to highly compensated jobs, but also for the overall benefit of our society. The wealth of a society is a function of its citizens' level of knowledge and the overall environment. As minority groups become a growing percentage of the overall population, the wealth of our society is dependent upon increasing STEM access and degree completion for these students along with the other traditional STEM students.

Limitations of the Study

This study focused on gathering the perceptions and lived experiences of a limited number of underrepresented minority students (n=10) at one public, four-year institution. While I explored deeply how participants make meaning of their experiences, it cannot be generalized to all students. Because this study focused on the phenomenon of how underrepresented minority students perceive their persistence in STEM programs, I did not interview students who dropped out of college. I deliberately chose to focus the research on successful students as opposed to those who departed. In addition, all participants in this study were enrolled in college immediately after high school due to the stipulations of the STEM PREP program. I did not interview non-traditional students who took a break between high school and college enrollment. I was aware of these potential limitations and was mindful of them throughout the research process, striving to do what I could to minimize the impact of potential limitations.

Implications

Accumulated cultural capital greatly influences one's college-going behavior and persistence (Berger, 2000; Wells, 2008). In addition, Wells (2008) identified a 45% probability gap for a higher cultural capital student to persist at a four-year institution than their lower cultural capital peers. Keeping this in mind, the findings from this

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research study have provided some promise. For underrepresented students who have not accumulated culture capital and are underprepared for college, it is important to take into account their personal development while addressing their academic under-preparation. Each of the identified contexts presents unique barriers, however, there are educational programs and cultural capital interactions that can mitigate these barriers and enable students to pursue STEM. In order to achieve the most systemic change that is designed to enable underrepresented minority student to pursue STEM careers, educational leaders must strive to establish policies that will help to diversify the population of students in STEM fields of study. Policies must be implemented that will: 1) provide secondary exposure to STEM coupled with academic preparation, 2) provide high school to college transition support, 3) provide academic support, 4) develop individual cultural capital, 5) instill faculty engagement / mentoring, 6) encourage participation in high impact socio-academic activates, and 7) provide expert information and advice on STEM career selection. Institutions must be mindful of the support that is provided to underrepresented students as a means of increasing STEM degree completion by helping these students with personal development and increasing their cultural capital. While the findings from this study are promising it is important that research in this arena continue. This study focused on the experiences of ten students at one research institution. The body of research can be expanded to understand if underrepresented minority students at other institutions have similar experiences. The following are suggestions to guide future research.

Recommendations for Future Research

1. Research the impact of cultural capital on college persistence and degree completion at four-year institutions related to STEM degree completion.

    a. Identify methods of assessing cultural capital as a means of identifying students, who will require additional support towards degree completion.

2. Analyze the impact of K-12 education policies that have the greatest impact on providing a rigorous high school curriculum while developing college expectations and college-going behavior for students from all socioeconomic backgrounds.

    a. For example: require students to take four years of math and have a solid foundation in algebra II to boost their college readiness and college success.

3. Evaluate post-secondary recruitment and retention practices that can be put into place to attract and retain less-advantaged students in STEM fields of study.

4. Investigate methods of personal development of identity for students from lower socioeconomic status

    a. During secondary education and

    b. While in college.

5. Examine the best methods to support students who are from low socioeconomic status and/or first generation status while transitioning to college

If the goal is to diversify the STEM workforce, it is essential that educational leaders to take into account the impact of these three contexts, paying special attention to socioeconomic status. If the focus is only on underrepresented minorities and you do not identify other factors, you may be merely helping minority students with high cultural capital complete STEM degrees. To ensure a diverse STEM workforce, it seems mutually important to make STEM career opportunities accessible to students of all socioeconomic classes as well as students who hold first generation status. It is important to identify students who are low socioeconomic status, first generation status, and academically underprepared and provide them with targeted support, keeping in mind that lower socioeconomic status students can require additional longer term support. The key findings from this study provided information on methods for secondary and higher education leaders that can be implemented to support the personal, academic, and cultural capital development of students as a means of improving the recruitment of underrepresented minority students to STEM as well as supporting them as they persist towards STEM degree completion. Table 7 highlights the recommendations related to targeted supports that can be put in place by educational leaders (for example: principals of middle schools, principals of high schools, and deans in higher education) to help underrepresented minorities persist and succeed in college. Each recommendation is noted as to whether it best applies to middle school, high school, and/or college.

Table 7

Recommendations for Pre-college and College Supports

Finding	Recommendation	Middle School	High School	College
Cultural Capital Agents	Develop K-12 teachers to be cultural capital agents who help to encourage low SES, first generation, and female students	✓	✓	✓

Finding	Recommendation	Middle School	High School	College
	towards academic enrichment, college, and STEM opportunities			
Cultural Capital Agents	Provide STEM career information and presentations to encourage low SES, first generation, and female students	✓	✓	✓
	Provide accurate advisement to low SES, first generation, and female students related to academics for college	✓	✓	
	Have university faculty mentors for STEM visit schools and share information about STEM and opportunities	✓	✓	
	University STEM faculty mentors available to support low SES, first generation, and female students and provide accurate advisement during first two years of STEM			✓
Cultural Capital Agencies	Agencies / organizations (for example: NESB and MESA), that encourage science and math, recommended to underrepresented minority students	✓	✓	✓
Lack of Academic Preparation	Provide summer academic enrichment / math transition classes (for example: summer programs) for low SES, first generation, and female students	✓	✓	✓
	Policies in place for all students to take four years of math in high school and get a solid foundation in algebra II		✓	
	Advise and make accessible honors, AP, and dual credit math classes for low SES, first generation, and female students		✓	
High Impact Socio-academic Integration	Provide early transition programs for low socioeconomic status, first generation, underprepared, and female students who want to pursue STEM programs		✓	✓
	Early system to identify low socioeconomic status, first generation, and underprepared students and ensure they get targeted advisement	✓	✓	✓
	Highly encourage STEM students to form peer study groups		✓	✓
	Advise low socioeconomic status, first generation, and underprepared students to obtain tutoring support	✓	✓	✓
	Offer freshman learning communities			✓

Finding	Recommendation	Middle School	High School	College
High Impact Socio-academic Integration	Recommend low socioeconomic status, first generation, and underprepared students involvement in student academic organizations		✓	✓
	Create research assistantships and advise low socioeconomic status, first generation, and underprepared students to participate			✓

Summary

Diverse peer environments expose students to new social networks and forms of cultural capital that can expand opportunities for success in school, college, and the labor market (Cobb & Glass, 2009). Students from lower socioeconomic statuses that lack cultural capital do not necessarily have the same access to college or academic preparation required to pursue a STEM field of study. Cultural capital agents played an important role in influencing underrepresented minority students in middle school and/or high school towards STEM fields by providing quality advice and exposing students to academic enrichment opportunities. Through the process of supporting students, cultural capital agents in turn helped individual development by increasing their cultural capital. Using this strategy, educational leaders can implement policy that encourages underrepresented students to pursue STEM fields and support them in college to increase their persistence. By providing focused efforts at the university level designed to support underrepresented minority students to timely degree completion, we can create a more diverse STEM workforce. In order to achieve this, we must make concerted efforts in both secondary and higher education to best recruit students as well as help them to persist and complete a STEM degree.

When secondary teachers and college faculty function as cultural capital agents for students in need, they begin to create new paths and opportunities for underrepresented minority students into STEM programs and careers. Middle schools, high schools, and research institutions can begin to provide targeted support for underrepresented minorities as a means of improving their persistence and STEM degree completion. Once the paths are created the challenge becomes to move traditionally underrepresented students in the STEM fields towards degree completion by supporting them throughout their undergraduate studies (Anderson & Kim, 2006).

As argued by Cobb and Glass (2009), education policy should be judged by the degree to which it benefits or does no additional harm to the least advantaged students. In this manner, systems and policies must be analyzed to determine how they are serving the least advantaged students and they must be modified to ensure that they enable students from all socioeconomic strata to have access to rigorous college preparation curriculum and engage in early STEM enrichment opportunities. The pervasive and deeply rooted nature of class differences means that education reform needs to move beyond an emphasis on individual motivation to a focus on institutional and social change (Aronson, 2008). Education institutions must be aware of and monitor the poverty status of students and provide targeted support in order to avoid replication of socioeconomic stratification. It would be beneficial to develop explicit connections or articulations between secondary and higher education. It is equally important to provide cultural capital agents who can explicitly support low socioeconomic status students to help develop their cultural capital in a manner that helps them navigate STEM and

successfully attain an undergraduate degree, which ultimately impacts their lifetime earnings.

While over the past decades there has been greater access for underrepresented minority students to attend college (two-year and four-year institutions), this has not translated into equal representation in science and engineering degrees and careers. To return to one of the founding principles of our nation, as educational leaders, we need to examine current education systems, economic systems and policy to ensure that we attain democracy in education. To ensure that highly technical fields are accessible to all it is necessary to actively increase the academic preparation and participation of underrepresented minorities in science, technology, engineering, and mathematics (STEM) programs of study. This in turn will increase the diversity and expand our STEM workforce, which benefits the nation. In order for our country to remain competitive in the global scientific arena the nation must have the will to provide quality STEM education to students from all socioeconomic strata.

To fully achieve the democratic ideology on which our nation was founded may require us to pursue reforms of capitalism (Bowles & Gintis, 2002), which is a daunting proposition. In the interim, educational leaders must examine the outcomes of our educational system and enact the necessary policy reforms to serve all students. It is important to recognize that schools are social institutions that transmit culture. It is integral to examine restructuring schools and systems to ensure that they will confer benefits to all students, not solely to privileged groups. With the political will to provide equality and educate all citizens we can begin to make the necessary transformations.

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Appendices

Appendix A - Carnegie Classification of Academic Institutions

The Carnegie Classification of Institutions of Higher Education is widely used in higher education research to characterize and control for differences in academic institutions. The 2005 version of the Carnegie Foundation for the Advancement of Teaching's basic classification scheme for colleges and universities is more complex than previous versions and includes subcategories, new names, and new criteria for categories. Academic institutions are categorized primarily on the basis of highest degree conferred, level of degree production, and research activity. *In this report, several categories have been aggregated for statistical purposes. The characteristics of those aggregated groups are as follows:

- *Doctorate-granting universities* include institutions that award at least 20 doctoral degrees per year. They include three subgroups based on level of research activity: very high research activity (96 institutions), high research activity (103 institutions), and doctoral/research universities (84 institutions).

- *Master's colleges and universities* include the 663institutions that award at least 50 master's degrees and fewer than 20 doctoral degrees per year.

- *Baccalaureate colleges* include the 767 institutions for which baccalaureate degrees represent at least 10% of all undergraduate degrees and that award fewer than 50 master's degrees or 20 doctoral degrees per year.

- *Associate's colleges* include the 1,814 institutions in which all degrees are associate's degrees or bachelor's degrees account for less than 10% of all undergraduate degrees.

- *Special-focus institutions* are the 806 institutions in which at least 75% of degrees are concentrated in a single field or a set of related fields.

- *Tribal colleges* are the 32 colleges and universities that are members of the American Indian Higher Education Consortium.

* Research activity is based on two indices (aggregate level of research and per capita research activity) derived from a principal components analysis of data on R&D expenditures, S&E research staff, and field of doctoral degree. See http://www.carnegiefoundation.org/classifications/ for more information on the classification system and on the methodology used in defining the categories.

Appendix B - IRB Approval Letter for Research

THE UNIVERSITY *of* **NEW MEXICO**

Main Campus Institutional Review Board
Human Research Protections Office
MSC08 4560
1 University of New
Mexico~Albuquerque, NM 87131-
0001
http://hsc.unm.edu/som/research/HR
RC/

20-Apr-2012

Responsible Faculty: Allison Borden
Investigator: Eleanor Radius
Dept/College: Educ Leadership Orgn Learning ELOL

SUBJECT: IRB Approval of Research - Initial Review
Protocol #: 12-117
Project Title: College Success: An exploratory study of how underrepresented minority students enter and persist in
STEM programs
Type of Review: Expedited Review
Approval Date: 19-Apr-2012
Expiration Date: 18-Apr-2013

The Main Campus Institutional Review Board has reviewed and approved the above referenced protocol. It has been approved based on the review of the following:

1. Expedited Review Study Application submitted 03/29/2012;

2. Investigator's Protocol submitted 03/29/2012;

3. UNM Consent Form (Faculty) version 04/03/2012;

4. UNM Consent Form (Students) version 04/03/2012;

5. "FSBP Students Needed!!" Recruitment Flyer submitted 03/29/2012;

6. Study Instruments: First Student Interview Questions, Second Student Interview

   Questions, FSBP Faculty Interview Questions, and Program Coordinator Interview

   Questions - all submitted 03/29/2012.

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Please note a verbal consent process was approved (a waiver of documentation of informed consent was granted) for observations of the FSBP meeting only. All other participant activities require a written, signed consent form.

Consent Decision:
Requires a signed consent form~Waived the requirement to obtain a signed consent form
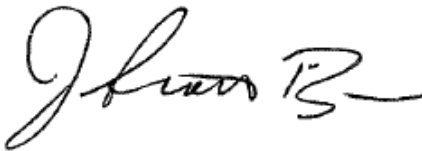HIPAA Authorization Addendum not applicable

If a consent is required, we have attached a date stamped consent that must be used for consenting participants during the above noted approval period.

If HIPAA authorization is required, the HIPAA authorization version noted above should be signed in conjunction with the consent form.

As the principal investigator of this study, you assume the following responsibilities:

- CONSENT: To ensure that ethical and legal informed consent has been obtained from all research participants.
- RENEWAL: To submit a progress report to the IRB at least 30 days prior to the end of the approval period in order for this study to be considered for continuation.
- ADVERSE EVENTS: To report any adverse events or reactions to the IRB immediately.
- MODIFICATIONS: To submit any changes to the protocol, such as procedures, consent/assent forms, addition of subjects, or study design to the IRB as an Amendment for review and approval.
- COMPLETION: To close your study when the study is concluded and all data has been de-identified (with no link to identifiers) by submitting a Closure Report.

Please reference the protocol number and study title in all documents and correspondence related to this protocol. Sincerely,

J. Scott Tonigan, PhD
Chair
Main Campus IRB

FSBP Students Needed!!

How do underrepresented minority students persist in STEM programs?

As a doctoral student at UNM, I am conducting a study of students who went through UNM's Freshman Summer Bridge Program (2006—2010) and have persisted in a STEM program of study. The goal is to gain an understanding of your educational experiences and what attributes you believe are most important for your college success.

If you are an underrepresented minority student (as defined by the NSF: Hispanic, African American, Native American, Alaskan Native, Hawaiian Native / Pacific Islander) and you are willing to participate in my study, please contact, Eleanor Radius at:

Eleanor Radius

eradius@unm.edu

 # Participants needed: 8-17

Timeframe: Spring 2012

Total Time: 2-3 hours
Participants will complete two interviews (1 hour each).

You are being invited because you can provide valuable insight into college persistence for underrepresented minorities in a STEM program!

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Appendix D - First Student Interview Questions

Demographics:

• Name	
• Ethnicity	
• Program of Study, # of credits completed	
• First generation college student Y/N	
• PT/FT student, # hours per semester	
• Campus resident or commuter student	
• Local, instate resident or out of state	
• Attended urban or rural high school	
• GPA (High school, College)	

1. Share your high school experience. How well did high school prepare you for college? Preparation for STEM?

2. How would you describe your experience in mathematics?

3. What was the most notable aspect of the transition from high school to college for you?

4. How well did you do on the COMPASS placement test? What level of math and English did you place into? As compared to your ACT/SAT score

5. How did you come to decide to enter a STEM program at the University? Did you have an advocate, a mentor, or a role model?

6. Why did you choose to attend this university (four year research institution vs. other institutions)?

7. How does your family feel about you going to college? About STEM?

8. How did the summer bridge help you transition from high school to college? What elements were helpful? What ideas might you have for improving the program?

9. How does faculty mentoring play a role in your academic career?

10. How did you utilize peer support while in college? Were they STEM PREP peers? Others?

11. What, if any, barriers do you experience related to attending college? (i.e. financial constraints, family responsibilities, etc.)

12. What do you perceive that you do to persist and be successful in STEM?

13. What are your career aspirations? How did you learn about this career?

14. Describe some of your values. How do you feel your values fit with the academic values here at the university? What, if any conflict of values do you experience?

15. How do you feel about your self-esteem? How do you feel that plays a role in your education?

In preparation for your follow up interview, reflect on your student experience. Jot down any ideas, feelings or stories you remember between the two interviews. If you have any documents or artifacts your feel are important bring them to the second interview.

Appendix E - Second Student Interview Questions

1. Since the last interview, have you had any reflections relating to your academic experiences or college success that you would like to share?

2. Reflecting on the previous interview have you had any thoughts about your social and academic integration at this university?

3. Reflecting on your overall educational experiences, is there one person or mentor who has helped you the most? If so, please describe who and how they have helped/supported you.

4. Reflecting on your educational experiences in college, which factors do you attribute to your ability to persist in college? Where did you learn this? How do you think you developed the ability to persist?

5. When do you expect to graduate? How do you plan to meet that goal?

6. Is there anything else related to your college experience as a student in a STEM program that you would like to share?

7. Follow up question related to trending topics out of the first interviews.

8. In preparation for your follow up interview, reflect on your student experience. Jot down any ideas, feelings or stories you remember between the two interviews. If you have any documents or artifacts relating to your educational experiences and/or college success, that you feel are important, bring them to the second interview.

Appendix F - STEM PREP Faculty Interview Questions

Demographics:
• Name
• Ethnicity
• Department at the university
• Which STEM PREP class do/did you teach? English, math, or computers?
• How long have you been teaching STEM PREP classes?

1. From your perspective, how does the STEM PREP support underrepresented minority students in pursuing STEM programs of study?

2. What do you perceive to be the biggest barriers faced by the STEM PREP students?

3. What did you observe that students experience while enrolled in a STEM program of study?

4. What is the FSB program's greatest strength?

5. How could the STEM PREP be improved upon?

6. Do you function as a mentor to the STEM PREP students? If yes, please explain.

7. Is there anything relating to this topic that we have not discussed that you would like to share

Appendix G - Sample of Matrix Used for Data Analysis

	1. HS Experience / Preparation	2. Math Identity	3. Transition HS - UNM	4. Mentor/Advocate
Ernesto	• 4 AP classes • AP Chem/ AP Calc AB/BC • My high school had a high dropout rate so I would say at my school you had to take your own initiative.	• Always was better at math than English • AP calculus • Math Tutor at UNM	• Adjusting to living away from home • HS do the bare min. • 1st year classes not hard, 2nd year much higher exp.	• Dad, he is very technically oriented • He helped me to develop a passion for computers • Family Mentor
Marco	• Tough. Did not speak English • Immigrant • HS in Mexico made me want to pursue Science/Eng	• Like Applied math • Pure math not my favorite • Naturally good at it	• STEM PREP helped me with English skills. I was not at home and had to speak English (ELL)	• Always knew I wanted to do Eng. • Latino eng. club helped me select chem E (Agency)
Carlos	• Wasn't focused on education • "just getting by" • During HS I partied, • It wasn't cool at my HS to study	• I did like Math • Highest math in HS was Algebra II D+ • Geometry D+	• Dev. Trans. (Future) • I decided that I wanted a good life and I should study engineering	• STEM PREP Coordinator • Friend (apply to UNM) • Chemistry Teacher HS
Manuel	• Did not prepare me all that well • Rural school had less resources • Maxed out HS curriculum	• Always good at math • Supported by teachers but not challenged in math	• "nobody slows down for you." • Responsibility – it is completely up to you	• No advocate • Dad (electrician) • Wanted a challenging field (engineering)s
Adnres	• Did not prepare me, subpar, needed more math • Have to advocate for AP classes • Classes are there but I missed taking them (i.e. Physics)	• Never bad at math • Placed into pre-algebra post HS	• Remedial Math • 116, 120, 121,122, 123,150, 160, 161, 264 (pre-algebra up to differential equations)	• CAD teacher at VHS • Project based learning captivated my interest in engineering
Mari	• STEM focus prepared me • [HS Teacher] focused on how college worked	• Love math	• Smooth prepared by HS teachers and summer programs	• Friends of mom, women engineers
Victoria	• As compared to bigger school in urban areas, I don't think we were as well prepared at my high school	• Started algebra in 8th grade • PREP at NMSU • Honors Calc. in HS	• Learning to balance freedom and responsibility	• Mid school science teacher encouraged me to sign up for NMSU summer STEM prog.
Rachelle	• HS did not prepare me for college	• I understood it but didn't seek out math • Like math now more than in HS	• Having to take initiative, self-advocate • Remedial math classes	• 8th grade science teacher who got me active in NESB
Carly	• Prepared me, I took honors or AP classes which gear you towards college and test taking	• HS really liked math	• Sheer number of people you interact with and meet • Much bigger network	• Physics teacher in HS pushed me to do FSBP • He held eng. meetings at UNM for HS students • Dad (family mentor)
Jasmin	• 2 yrs at small, rural HS did not prepare me • 2 years at urban HS helped to prepare me.	• My math was weak • But, when I transferred I think it got better	• Fine. I had left my parents 2 years early so I was used to that	• HS had career prep visits from univ. • Physics teacher in HS who was Chem E.

Appendix F - Sample of Coded Transcripts from Student Interview

[STEM PREP] Student Interview Transcripts –
Session 1 –   7/18/12   Session 2 – 7/22/12

Demographics:

Name	Victoria
Ethnicity	Hispanic
Program of Study, # of credits completed	Construction Management, Senior (120 hrs + AP credits)
First generation college student?	Yes. Mom has some vocational classes for her job, but did not get an AA.
PT/FT student, # hours per semester	FT 15-18 *Student enrollment*
Campus resident or commuter student	Freshman + half soph. on campus. Now commuter student. Rent off campus
Local, instate or out of state student	In-state
Urban or rural high school	Suburban/rural school in the southern part of the state
GPA (High school, College) *HS GPA*	4.2 HS, 3.5 UNIV

Interviewer	Share your high school experience. How well did high school prepare you for college? Preparation for STEM?
Participant *HS Prep*	Compared to bigger schools in [bigger cities], I don't think we were as well *K-12 comparison* prepared. They just had more options and I think their coursework was more rigorous than ours. I remember going into the summer bridge program and not *math* knowing how to do logs. And these other people were like, oh yeah I know how to *underpreparation* do those. But, I think it was a fluke that we skipped it. But, I felt a little bit lacking. But, I mean overall I think I did ok. Like I did well in high school so that meant I was paying attention. But I think with somebody with a more average GPA, I think it *HS Experience* might have been more difficult. They might not have been in the honors classes. I think more motivated people from my high school got the most out of it. So it wasn't completely awful, but I think it was a little bit less than what other people got.
Interviewer	How would you describe your experience in Mathematics?
K-12 exp.	I went into 7th grade doing pre-algebra when everybody else was doing a little bit *Math preparation* more generic math. Started algebra I in 8th grade. So then going into high school I *math identity* was already a year ahead. But my geometry teacher wasn't the best. But the next

K-12 exp. **STEM Support Program**	two teachers I had were good. It was challenging. I took the honors calculus my [*Time Mgt. /Responsibility*] senior year. I dropped basketball just so I could take it. And there was this STEM program called PREP and they held that at [state university]. And since I am from the southern part [of the state] it was the close 1st university in [southwestern state]. [*math preparation / STEM enrichment*] So I would go over there for three summers starting after my seventh grade year and basically it was like summer bridge, it had computer science, math class, English class, and we got presenters every day from different fields of engineering, science, and math. So I remember some of the trig and stuff from there, very vividly. So I [*K-12/HS enrichment*] think that helped me. It supplemented my education in high school. I think I got [*math identity*] credit. It was a really good program. So I felt ok at math at the high school level. [STEM PREP] divided students into groups for math and I was in the advanced [*HS underpreparation*] group. I felt ok, but there were sometimes that I felt a bit lacking. Where the [*academic expectations*] others knew more of what they were doing. Were maybe more used to the level of [*HS under preparation*] homework. Because I remember it was really long homework assignments. And my roommate she just sort of blazed through it. But, I was always looking at it like why? But, I got through it. I didn't do awful in there. I think I did ok. I did better than some who I thought were more prepared than me.
Interviewer	What was the most notable aspect of the transition from high school to college for you? [*responsibility*]
	I want to say the freedom and the responsibility. Because there is a lot more responsibility but there is a lot more freedom also. So it was learning how to juggle [*time mgt.*] both of those.
Interviewer	How well did you do on the COMPASS placement test? What level of Math and English did you place into? As compared to your ACT/SAT score
Math Placement for College	I think we were all testing to see if we could start right into Calculus I for [*math underpreparation*] engineering. I think I missed it by like 8 points. So I took pre-calculus and [*College math placement*] trigonometry. I doubled up the first semester. It turned out good. I had really good

math underpreparation – honors Calculus class in HS then Trigonometry placement in College

less rigorous HS math

		trigonometry. ~~I doubled up the first semester.~~ ~~It turned out good.~~ I had really good *[math identity]* teachers. So I ended up getting an A+ in pre-calc. I think I am intuitively good at *[self-esteem / english identity]* English because my AP honors English teacher was not good. Because some of us were able to score ok on the test in spite of him. I think I may have scored a four on that. And so either based on that or my ACT scores, I think I got a 31 so I skipped 101 and 102. But, what happened is that I didn't get credit for 102. So I had to have it replaced with the Engineering requirements. But, thankfully one of my *[prep by HS]* honors classes substituted in there. So I only had to take up to English 219 for my major. That was the only English class I had to take.
	Interviewer	How did you come to decide to enter a STEM program at the University? Did you have an advocate, a mentor, or a role model? *[MS Cultural Capital Agent]*
[STEM Support Program] *[Advocate for STEM]*		I think it goes back to the program prep that I was in. One of my science teachers *[Mentor]* was talking about it in class. He encouraged me and some others to really apply to it. And so I did. And I think he even submitted the form. That was geared towards STEM programs. And I think just since then I just got it in my head to do that. I think it really comes down to that. He really encouraged us. If it hadn't been for that I don't know where I would have ended up.
	Interviewer	Why did you choose to attend [flagship university] (four year research institution vs. other institutions)?
[Scholarships]		In high school there was this test I had to take the PSAT and I got a letter that said I *[achievement]* was a national Hispanic merit scholar. So I started getting letters in the mail from universities. Some would waive my application fee, and others like [neighboring state university] offered $93,000. I think maybe I got one from [flagship university] too. [Flagship university] and [state university] were probably the same offer. It *[Financial Support]* promised to cover four years of tuition, and room and board so basically a full ride. I don't remember how they worded it. I remember sitting there doing calculations on how much it would be to attend [neighboring state university] and I didn't think I

	would have enough money. So that's how I ruled them out. I didn't want to go too, too far from home. I don't know, I guess just culture shock. I figured that [flagship university] was a good distance and still close enough. And then most people in our high school ended up at [state university] so we didn't want to be there with them. *identity* We didn't want to end up the same as everyone. So my best friend and I and *(city)* another really good friend, she was valedictorian, she came up to ████████ too. *peers from HS* So there is a handful of people from my high school at [flagship university] but definitely not as many as there are at [state university].
Interviewer	How does your family feel about you going to college? About STEM? *culture*
Family Perc. of STEM	I think they are really proud and they are always very encouraging of whoever is in college. For everybody to finish their education. My great grandma will always ask me how it is going and stuff. They always ask me about school, especially since I am *family culture* far away a lot of the time. And it's a pretty close family we meet at my great grandmothers every Sunday. And since we're on the other side of town we go every other Sunday. You know so we see everybody very frequently. So whenever I go down they always keep that in mind and they always ask me how it is going. I *family perceptions of STEM* am not sure how they feel about STEM. I think they just sort of, they might be a little bit impressed because they don't know what I am talking about. It is kind of *Language (dual) difficult to explain* hard to describe to them. Especially because it is in Spanish that I will have to be saying it and it is harder when it is technical. Are you fluent in Spanish? I grew up *Bi-lingual* speaking both. My mom speaks English at home and Spanish. But when we are *Family language preference* with other family members we mostly speak Spanish. My grandma only speaks Spanish.
Interviewer	How did the summer bridge help you transition from high school to college? What elements were helpful? What ideas might you have for improving the program?
	I think it was really helpful in that they were not easy on us. Especially in Math. *academic expectations*

responsibility　　　*college transition*

There was a lot of homework. That was a readjustment for me because I skated

through high school. Going through that it became there is only so much time in

transition to adulthood

the day to finish the homework. It changed me to the faster track of life. Always

rule breaking

doing homework, we all lived in the dorms... we would go to Denny's at midnight. It

time mgt.

was learning to balance everything I guess. Finding quiet time to do homework,

time to work together, but also having fun with each other because I don't think we

know each other coming into it.

	Interviewer	How does faculty mentoring play a role in your academic career?

Mentor/Faculty Advisement on STEM Program

Cultural cap. agent, mentor, support

I met [STEM PREP Coordinator] and I just always knew I had him to go to if I had any

questions. We have to go and get advised every semester. So there was that

interaction to make sure... and I guess to make sure you are on the right track. I

Advisement

3rd year advisement better.

don't know. There hasn't been one person, but [STEM PREP Coordinator]. My

3rd year faculty relationships formed

advisor now is very helpful. She remembers my name. I can shoot her an email and

Faculty Mentor/interactions

she will take care of it right away. And now I met Dr. [Jones] and Dr. [Smith] and I

could go to them if I needed guidance or something. But, that is more recent.

	Interviewer	How did you utilize peer support while in college? Were they [STEM prep] peers? Others?

Peer Advisement/Support

Mostly it is everybody sort of discusses what classes they have taken, what they

need to take, what issues they have encountered. I guess it helps let me address a

academic planning

problem before it becomes a problem. So it is really helpful in planning your

schedule for the next couple of semesters. Especially now there is a lot of peer

Peer Support/Collaboration

support in finishing homework and projects. Now that I am in the same department

Peer Support

you start to make friends. You see the majority of your class transfer from class to

class. I ate lunch with the same people every Tuesday and Thursday. I think if you

peer support

are open to it there are always folks to help and work with. I sort of stumbled

between random students in different classes. But then I had recently a class last

Leader of student organization		fall with the girl who was my roommate, so sometimes I asked for help on homework. I am the only construction mgt student from my [STEM PREP]. So in the beginning we were taking similar core classes, but now there is not too much ~~student organization~~ overlap. There is [student engineering organization], so [Manuel] and I have always ~~Career preparation~~ been connected through that and we will worry about careers together. You are ~~Leadership opportunity~~ going to be the president of this organization? Yes, it will be a lot of responsibility. But, I also know that [Manuel] will be on the board to help out.
	Interviewer	What, if any, barriers do you experience related to attending college? (i.e. financial constraints, family responsibilities, etc.) *financial support*
Financial support *No barriers*		Not really. I have had it pretty easy. I have had everything paid for. I might run out of money at the end of the semester, but it has been pretty generous. I get whatever they don't spend. But now that I moved out of campus I get $7000. $4000 is for rent and I pay that off right in the beginning. My best friends' parents bought a house so I rent a room in the house. So that covers my utilities and ~~responsibility~~ everything. So I just have to manage the remainder and make it last.
	Interviewer	What do you perceive that you do to persist and be successful in STEM?
Academic Planning		I don't know. I guess, I don't see myself doing anything different than my friends. I think it is just wrapping your head around it. The difficulties. It is not as simple as ~~personal factor of persistence~~ other majors, it is a big commitment and you just have to devote the time and ~~culture~~ effort to it to be successful at it. But, I think it has been engrained in my head since ~~Parental academic expectations~~ I was little. My mom always said, "do your best." She didn't say be an A student. She said do your best. Just make sure you fulfill all the requirements. Just trying to ~~responsibility~~ stay on top of it and make sure you look a head a little bit because, you know, like ~~academic planning~~ as far as planning a semester goes, especially now there are a lot of classes that are pre-requisites for another and are only offered in the fall or spring, so you just have to plan it out, you know be vigilant make sure you're not missing something very

		important that will keep you in school another year or something at your own cost. *academic expectations* For my scholarship I have to keep a 3.3 GPA. So it is always keeping that goal in *Responsibility* mind. So each homework assignment matters. I have to assign importance to everything because it all really matters.
	Interviewer	What are your career aspirations? How did you learn about this career?
Career Selection		I always thought that I would be a project manager. But right now I am doing this *Career preparation / Career Selection* internship with federal highways and it has shown me a whole other side to construction and planning. Because they allocate money to help the dept of transportation in [northwestern state] that is where the majority of the money for roads comes from, like in [another state] it is just sort of a side thing not there main flow of money, so here they are really dependent on the money so here what like they do is like they have operations engineers who just oversee projects and make *career interest / selection* sure they do everything correctly. I could do something behind the scenes like that. I don't even know what I want to do, but we'll see where I get hired. It would be nice to do something like this because you don't have to be onsite everyday. My freshman year I took and auto cad class and every Friday we had presentations we had to attend. And professors would come in and discuss different fields. I *Faculty mentor/role model* think it was Dr. [Jones] and she came in and talked about different aspects of engineering and I remember her saying that she found construction management to *Planning* be the most fulfilling thing she had done. So I did a little research on it and found *Career Selection* the pay was just as good. So I switched to construction management my first semester. It just sounded like something that I always wanted to do.
	Interviewer	Describe some of your values. How do you feel your values fit with the academic values here at [flagship university]? What, if any conflict of values do you experience? *personal values*
		I think they line up. Be honest. I hold myself to a high standard. It is in my head to

		do my best work. Not try to cheat people out of anything. Honesty is the best *Ethics* possible. You don't want to do anything that will cost you your career. You don't want to cheat the system. It is just not worth it. I just try to be nice to people.
	Interviewer	How do you feel about your self-esteem? How do you feel that plays a role in your education? *Gender*
Self-esteem balanced.		I think my self esteem is good, sometimes it is harder being in STEM as a female and a minority. I think in [southwestern state] the minority aspect plays less into it than else where. I think I can do it just as well as anyone else in the class can. I know I *belief in self* *Positive belief* can do average if not at least a little bit better. I always think it is possible. For *esteem fluctuates* example when my roommate could do logs better than me. It takes a dip and you *Gender* go into your shell. But it seems pretty level now. I am one of two girls in construction management. So in our little cohort we are the only two girls. It is very male dominated in construction, and a lot of my people in my program I am one of the few who doesn't have field experience. So that makes me feel a little bit *under prepared for career* behind. I am not as confident in posing questions. I think maybe it is a stupid *self-esteem* question and all these people already know it. So I don't think it is something that I can't gain. I just don't have it right now.

Working on gaining confidence in field of study – male-dominated field.

7/22/12

	Interviewer	Since that last interview have you had any reflections relating to academic experience or college success?
	Participant	I have been trying to think. But I am not sure. Maybe we could come back to this at the end.

[Participant did not have an answer for this during the interview. She reflected on the question, and emailed me her reflection two days after the interview.]

I feel like I've been very lucky and had a greater opportunity for success because of *academic STEM enrichment* programs like prep and [STEM PREP]. Without [HS PREP], I'm not sure that I would *college transition* |

have pursued a STEM degree and if I had, I would not have been as knowledgeable

about what that entailed. Coming from an area that is so dominated by minorities,

though, I've never really felt like I was contributing to (hopefully) rising statistics of

Hispanics in STEM, or that I was breaking barriers. I typically don't feel any more

special for doing it, but sometimes I'm reminded of how uncommon and difficult it

is. If I had been brought up in another place with less of a Hispanic population, I

might feel like I stand out more, but [my home town] is a special place! I came from

Low SES

a poorer school, but that wasn't because of my race, because there were richer

schools nearby with huge Hispanic populations. This has probably skewed my view

under preparation / less resources

of things a bit. If our school had had more money, though, I think all the students

would have a chance at being better prepared for college, though, without signing

HS prep for college

up for Honors or AP courses like I did. Some people just didn't have the foresight to

STEM support program

prepare from a younger age like I did thanks to my participation in prep. I think

personal factor

success comes down to the individual, though. If somebody's driven enough, they

will fight through any set backs and work hard to get through the difficult

financial support

curriculums in STEM. In this area, the support for minority groups is high and it

should enable everyone to feel empowered and like they have the ability to do

whatever they set their mind to.

Cultural Cap.
Agent advocated
for STEM in MS

Interviewer	Reflecting on the previous interview have you had any thoughts about social or academic integration? *Network*	
Participant	The [STEM PREP] really helped with that, I think. Because I had people that I knew. At a place where I only knew a handful of people. My roommate asked, how did I *Peer/ friends* know so many people? Yeah, so she was jealous of my connections.	
Interviewer	Reflecting on your overall academic experiences is there one person who has been a mentor or advocate? How did they help or support you? *Faculty Mentor*	
Participant	Probably [STEM PREP Coordinator]. I would say it is between [STEM PREP *mentor (HS)* Coordinator] and my high school biology teacher. Well they were presenting	

Academic.
Integration

Faculty Mentor
Cultural Capital
Agent

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Research Assistantship		opportunities to me and writing letters of recommendation for me. IT is just nice to have their support and knowing that I could use them as contacts. And [STEM PREP *High impact socio-academic integration* Coordinator] got me into his research assistantship program. And I think that really *faculty integration* helped because it put me in contact with two more faculty members who I could go *career prep* to. And I think it really helped out my resume. And probably helped me get this *Career prep* job/internship.
	Interviewer	Reflecting on you educational experiences in college which factors do you attribute to your success in college?
Career Goals	Participant	I think support from friends or family. I think that has been really helpful to me. Because I know they are cheering for me or they are in the same position as me and *support networks* everyone is just trying to get through. I think just having support networks. Yea I *Personal factor* don't think I have ever been a quitter. I always see it through to the end. I always think by tomorrow this will be done with some way or another. And that is just how *career goals* I get myself through stuff. So just keeping my eye on the end goal. Just persisting. I *family expectations* think I have just always been that way and it is probably just down to my mom. *family support* Because she is the same way. I think with her support and encouragement. I don't know I have just always been that way.
	Interviewer	When do you expect to graduate? And how do you plan on meeting that goal? *academic planning*
Academic Planning	Participant	Next May, May 2013! I already have my final year planned out. That is why I am taking my summer class now because I did not want to have 18 hours for either semester. I didn't think that it would be possible to graduate on time, until half way through last semester, I think I thought I was going to go over another semester *Planning* then I sort of sat there and figured out what I needed around the time that I had to go get advised so I started planning for the last year. And then I realized that I could *academic planning* do it. So just always planning ahead. I think last semester I had 18 hours and then *HS preparation* there were two honors classes that counted for the other extra and one counted for

		two. So it just helped me out in the end because now I don't have to worry about it. *responsibility* So just keeping track of the classes that I need to fulfill. And now I have the *Career preparation* internship that is also a requirement. So now it is straight forward. More so than before.
	Interviewer	Is there anything else related to your college experience as a student in a STEM program that you would like to share?
	Participant	Not sure. I guess it is kind of hard to see what stands out because I have never done *Gender* a different one? There is definitely a disparity. I think less so in civil engineering *gender* than other fields. Because I know that [Manuel] will talk about one other girl in his electrical engineering classes. At least in civil engineering I want to say about a third *more females in civil eng.* of the class will be girls sometimes. I mean you can see the difference. And it is a lot harder for girls to make their way. And just like here during the internship I was talking to one of the women in the offices and she was telling me how difficult it was for her and even after getting so much experience and being in a high position she still has to prove herself, or had to when she first got into that position. So I know that it will be difficult.

Gender Female vs. male

Male-Oriented field