

DISSERTATION

PERCEPTIONS ABOUT MATH PLACEMENT AND PRE-CALCULUS/CALCULUS MATH
COURSES AMONG COLLEGE FIRST-GENERATION,
LOW-INCOME, STUDENTS OF COLOR

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Ft. Collins, Colorado

Fall 2018

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ABSTRACT

PERCEPTIONS ABOUT MATH PLACEMENT AND PRE-CALCULUS/CALCULUS MATH COURSES AMONG COLLEGE FIRST-GENERATION, LOW-INCOME, STUDENTS OF COLOR

The purpose of this study was to explore first-generation, low-income, students' of color experiences with math placement and pre-calculus/calculus courses, focusing on their self-belief in being successful in math. As part of the Progress Through Calculus National Science Foundation research project, eight first-generation, low-income, students of color in STEM at one institution were studied with interviews and focus groups. These students completed pre-calculus/calculus courses during the 2017-2018 academic year.

Summarizing how first-generation, low-income, students' of color identities impacted college experiences for these students, a strong dedication to learning and a deep value in seeing the benefit of higher education were combined with an extreme pressure to succeed. As one of the first experiences with students in college, the math placement process revealed anxiety with this high stakes exam. This exam was viewed with a fixed mindset, where most of the students did not take advantage of the minimal support offered. For the majority of students, the placement exam did not enhance their self-belief in being successful in college math, and half the students enrolled in a math course that was different than their placement results.

Student experiences in math courses that positively influenced self-belief focused on the transformation as engaged learners; which included valuing practicing, devoting time, gaining mastery with mathematical concepts, working with other students, and understanding the importance of asking for help. Course components students shared that influenced their self-

beliefs to be successful in math are illustrated within inclusive pedagogies in the classroom and, in turn, support structures to enhance student learning. Particular aspects of inclusive pedagogy included group active learning, diverse experiences and approaches, and a community of caring. Highlighted support structures were course feedback, learning assistants, and the math lab.

A community approach to learning math was illustrated by integrating the aspects of self-belief that empowered engaged learning with inclusive pedagogies and support structures. Promoting a community approach to learning encourages self-belief in math success and may positively influence math completion of first-generation, low-income, students of color.

ACKNOWLEDGEMENTS

My doctoral journey has been extremely impactful and could not have been accomplished without the support and love from my family, friends, mentors, and colleagues. Thanks to Jimmy my partner for experiencing alongside me all the successes and challenges and supporting me throughout the process, Rachelle my daughter for giving emotional support, providing math tutoring in preparation for the GRE, and sharing her technology expertise; and Domenic my son for encouraging me at a low point, and being proud of my accomplishment. It was profound to learn from my children in this process. Mom and Dad, you taught me persistence and consistency that were essential during this marathon, and I will always appreciate the on-going words of encouragement from Kathy and many others.

Dr. Susana Munoz my adviser, continually challenged me to have high quality research and writing, based in her intentionality, focus on access, and scholarly expectations. On my committee, Dr. Jess Ellis Hagman inspired me with her energy and determination, and I will always be grateful that she included me with the Progress Through Calculus Research Project. Dr. Paul Thayer my mentor and committee member, is a role model in his passion and dedication to improving collegiate experiences of unrepresented students and setting a high standard of performance both professionally and in research. Others in the Higher Education Leadership Program include Dr. Linda Kuk who implemented the HEL program, faculty Dr. Sue Lynham, Dr. Gene Gloeckner, and my cohort colleagues including George Marquis, who notably impacted my learning. Finally, to the students in my research who were so open about sharing their inspirational lives, and that I greatly admire.

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CHAPTER 1: INTRODUCTION

To become more pivotal at inspiring students of varying backgrounds to build a better world through education, higher education institutions need to graduate more first-generation, low-income, students of color to close the lower graduation rates that remain between underrepresented and majority students. Among 4.5 million college students from 1995-2002, six-year graduation rates for first-generation, low-income students were 44% lower than continuing-generation higher-income students (Engle & Tinto, 2008). Additionally, according to the National Center for Education Statistics (2010, July), slightly over half of the degrees earned in 2008 were Whites (53%) and Asians/Pacific Islanders (54%), compared to lower percentages for Hispanics (48%), Blacks (47%), and Native American /Alaska Natives (46%).

This study focuses on math completion as one way to address this graduation gap within a framework of developing student talent and implementing institutional strategies to enhance academic success, rather than defining student deficiencies that need to change for success. The theoretical framework of self-belief is utilized to research ways to potentially enhance success in math that may mitigate the negative influence of stereotype threat of first-generation, low-income, students of color. Utilizing the power of positive psychology to understand how higher education institutions can be more instrumental in influencing success in math, will hopefully assist to increase first-generation, low-income, student of color graduation rates.

Problem Statement

Currently there is societal pressure for higher education institutions to improve accessibility and accountability of educating students. According to Stevens (2015), the accountability revolution has come to higher education with expectations of higher efficiency and productivity in educating our society. Along with increased accountability, there is a focus

on enhancing accessibility to higher education illustrated by Archibald and Feldman (2010), who state educational attainment needs to be a national priority, since earning a college degree is imperative for social mobility. Improving accessibility and accountability during a time of increased dissatisfaction of higher education (Crow & Dabars, 2015) creates even more demand to make changes.

Higher education institutions have partially improved these issues by pointing out the changing college student demographics as one facet of improving accessibility and by focusing on completion rates to enhance societal accountability. Colleges have transitioned from educating a fairly homogenous elite group of students to educating a more diverse group of students, including first-generation, international, veteran, low-income, and students of color (Kezar, 2001). In relation to first-generation students, according to the National Center for Education Statistics (2014, October), 33.5% of students had parents with a high school diploma or less and 28.1% had parents with some postsecondary education without a bachelor's degree in 2011-2012. However over the past twenty years, the number of first-generation high school students has declined from 77% in 1980 to 62% in 2002 (Cahalan, Ingels, Burns, Planty, & Daniel, 2006).

Regarding low-income students, approximately 27% of all undergraduate students are Pell Grant recipients, with the majority of these students coming from households in the bottom income quartile (Cook & King, 2007). Focusing on race/ethnicity, 2013 college enrollment for White 18- to 24-year-olds (42%) was higher than the rates for their Black and Hispanic counterparts (34% each). The White-Hispanic college enrollment gap narrowed between 2003 and 2013 (from 18 to 8 percentage points); however, the White-Black college enrollment gap did not change measurably (Aud, Fox, & KewalRamani, 2010, August).

In addition to educating a more diverse population, increased accountability has assisted in the transition from a philosophy that some students are incapable of college-level work to one that focuses on supporting all students to be successful. For instance, more emphasis has been placed on student learning as the core goal of teaching in higher education as one way to enhance student success. Integrating inclusive classrooms is a strategy to create an optimal learning environment, especially for underrepresented students.

Ramsden (2003) shares teaching and learning are linked, and faculty must listen and learn from their students to adapt their teaching practices. A focus on student learning is created within inclusive classrooms where instructors and students work together to create and sustain an environment in which everyone feels safe, supported, and encouraged to express her or his views and concerns (Saunders & Kardia, 2011). More specific ways to create inclusive classrooms focusing on student learning are implementing group work and active learning (Miller, 2005), incorporating respect for multiple perspectives and varied experiences of a range of students (Saunders & Kardia, 2011), and demonstrating care for students (Johnson & Hanson, 2015).

Beyond classroom pedagogies, Kuh, Kinzie, Buckley, Bridges, and Hayek (2006) summarized university interventions across the country that have been implemented to support students, such as enhanced orientation and advising, early warning initiatives, learning communities, and first-year seminars. Additionally, learning analytics or data-driven decision-making is another tool that helps colleges identify and implement strategies working to support student success (Picciano, 2012). Examples of learning analytics findings that impact graduation include early completion of courses, such as math and composition, new pedagogical enhancements in general education courses focused on academic success, and outreach to students at risk of not achieving well in a particular course or program of study.

Stagnant Degree Completion Rates and Graduation Gaps

Despite changing demographics of students enrolling in college and student success initiatives, completion rates have only slightly increased and gaps between first-generation, low-income, and continuing-generation higher-income students continue to exist. According to the National Center for Education Statistics (n.d.), six-year graduation rates from the first institution attended for first-time, full-time bachelor's degree-seeking students at four-year, postsecondary institutions, have only increased from 57.8% in the 2003 cohort to 59.4% in the 2007 cohort.

Focusing on first-generation, low-income students, Engle and Tinto (2008) state, based on data from the National Center for Education Statistics with 4.5 million college students from 1995-1996 through 2001-2002, after six years 11% of first-generation low-income students had earned bachelor's degrees compared to 55% of continuing-generation higher-income peers. The statistics for racial/ethnic groups are more promising with the number of bachelor's degrees conferred to Hispanic students, which more than doubled between 2002–03 and 2012–13, and the number conferred to Black students increased by 54%, compared to little growth with Asian/Pacific Islander, White, and Native American/Alaska Native students increasing by smaller percentages (Aud et al., 2010, August).

The varying levels of progress in college completion rates is compounded by the increased costs of higher education, making it more challenging to educate a diverse student population (Reindl, 2007). Although higher education institutions have made adjustments and improvements to increase accountability and accessibility, more substantial changes are needed to graduate a larger portion of first-generation, low-income, students of color.

Graduation Gaps Related to Math Completion

One avenue to potentially improve the graduation gap of first-generation, low-income, students of color is math completion, a standard general education college requirement at most institutions of higher education. Looking more in-depth into math completion are issues of math readiness, the influence on students' overall perceptions of being prepared for college, and gaps in math completion for first-generation, low-income, students of color. In regard to math readiness at community colleges, the Carnegie Foundation for the Advancement of Teaching found more than 60% of all college students need developmental/remedial math courses and at least 70% of those students never complete the classes, leaving them unable to obtain their degrees (Bellafante, 2014). Additionally at four-year universities, 20% of students place into a math remedial course (Jones, Sugar, Baumgardner, & Raymond, 2012). Colorado State University students in need of remediation (math being the predominate remediation area) have approximately 10 percentage points lower rates of retention and graduation compared to students who do not need remediation (Colorado State University, 2015b).

This lack of college math readiness may influence students' initial collegiate experiences. Based on research at a community college by McDaniel (2012), when students fail the math college placement test, they reported receiving a clear signal they were not prepared for college. Furthermore, Lundell and Higbee (1999) acknowledge stigma and stereotyping for students placing into developmental education courses. Once in college math courses Gordon (2008) found, each year about 50% of students earn a grade of A, B, or C in college algebra, leaving half of the students not passing the course, which may also influence students' perceptions of their potential to be successful in college.

Comparing first-generation and continuing generation high school graduates and math completion in 2003-04, proportionally fewer first-generation students took math courses, such as trigonometry/statistics/pre-calculus (27% vs. 43%) and calculus (7% vs. 22%) than continuing generation students (Cataldi, Bennett, & Chen, 2018). An analysis of first-generation students' college transcripts between 1992-2000, 55% of the students took at least one math course in college compared to 81% of the students whose parents held a bachelor's degree or higher (Chen & Carroll, 2005).

Concerning students of color, gaps in math scores start at a young age. According to the National Association of Educational Progress (2009, July), findings for both grades four and eight in mathematics showed White students had average scores at least 26 points higher than Black students on a 0-500 scale, even though these nationwide gaps were narrower than in previous assessments. Additionally, at Colorado State University (2016), after controlling for prior academic preparation; first-generation, Pell Grant eligible, students of color were significantly less likely to place into college algebra and complete three credits of math during the first year compared to their peers.

These issues of math completion may influence graduation rates. When considering the relationship of math preparation and graduation, according to Jones et al. (2012), for students at four-year institutions who needed remedial math courses, fewer than one-third completes bachelor's degrees in six years. In addition to math readiness, the timing of taking math may impact graduation. Adelman (2006) found 71% of students who took math by the end of the second year in college graduated, compared to 38% of students who did not take math in their first two years. Additionally, at Colorado State University (2015b) based on data between fall 2002 and 2010, completion of three credits of any math course during the first year was

positively associated with higher graduation rates compared with students who did not complete a math course during their first year.

Broadly, the lower math completion rates of first-generation, low-income, students' of color, the association between math completion and graduation, and graduation gaps for first-generation, low-income, students of color; confirm challenges for these students. Further research into the experiences of underrepresented students and math may provide insights in developing strategies to promote their collegiate success.

Purpose of the Study

The purpose of this study is to explore first-generation, low-income, students' of color experiences with math placement and pre-calculus/calculus math courses. More specifically, this study focuses on how university factors influence the self-belief of first-generation, low-income, students of color to be successful in math. This research might provide more insight on how emphasizing self-belief can enhance math completion for first-generation, low-income, students of color, which may impact the graduation gap for these students.

Research Questions

To gauge first-generation, low-income, students' of color experiences with math within this qualitative case study, the following questions will guide and inform this research.

1. How do college first-generation, low-income, students of color experience math placement and pre-calculus/calculus mathematics courses?
2. What university factors influence the self-belief of college first-generation, low-income, students of color for success in math?

Rationale

As more first-generation, low-income, students of color attend college and higher education institutions focus more intensely on graduation rates, further understanding is needed on new or enhanced approaches to increase these students' success. My interest in this study stems from my personal and professional experiences, along with an enhanced national focus on first-generation, low-income, students of color.

As a first-generation student, I am the first in my family, including my siblings, to graduate from college. At the time, I never considered being first-generation was a disadvantage to obtaining a college degree. As a high school student, I was interested in and did well in math, but had a disempowering experience in college pre-calculus in a self-paced instructional format, mismatched with my learning preferences. This math experience still sticks in my mind as one of the most difficult to navigate when I was learning how to be a successful first-year college student. Much later, I had to regain my math skills for taking the GRE and was empowered by relearning the material with a lot of effort and support.

Along with my personal experiences, as an academic advisor, I advised many students who struggled in math and witnessed how this experience influenced their confidence to succeed in college and their intended program of study. Currently, as a college administrator overseeing a student success unit offering many services to first-generation, low-income, students of color, I daily witness the differences that support and advocacy make for these students.

On a national level, there is energized attention to support first-generation, low-income, students of color to graduate at higher rates, which hopefully will make this timely research impactful. My passion and expertise in supporting first-generation, low-income, students of color, along with the imperative needs for higher education to improve support for these students

create a synergy for this research to contribute to increased graduation rates for underrepresented students.

Significance of the Study

This research will provide findings about first-generation, low-income, students' of color experiences with math, which can be utilized to offer recommendations for administrators implementing student success initiatives, math departments who oversee the math placement and pre-calculus and calculus coursework structures, and faculty who teach math courses. This research will hopefully help increase graduation rates and provide career opportunities. For instance, first-generation graduates among 2007-2008 bachelor's degree recipients, have similar rates of full time employment and comparable salaries as their non-first-generation peers (Cataldi et al., 2018). Increasing the graduation rates of first-generation, low-income, students of color will also enhance the accountability of higher education institutions in closing graduation gaps with underrepresented students, and make a difference in educating a more diverse society.

Theoretical Framework

This study is completed within the perspective of promoting the strengths and assets of students to encourage student success, rather than defining deficits and expecting students to compensate for these deficits. Building on strengths is based on the power of positive psychology, the study of conditions that influence the optimal functioning of people (Gable & Haidt, 2005). Theories to inform this perspective are stereotype threat (Steele, 1997), which challenges college success, and self-belief (Bandura, 1977; Dweck, 2006), which can potentially mediate challenges and promote academic success. Combining this positive framework with psychological models that influence students' experiences in college culminate in a concept

called thriving, a framework to help students fully benefit from higher education (Schreiner, Louis, & Nelson, 2012).

Stereotype threat theory asserts that negative stereotypes of one's performance, based on his or her social group, can place individuals at risk of lower performance (Steele, 1997). In response to the negative influences of stereotype threat, positive psychology theories of self-belief are used with Bandura's theory of self-efficacy and Dweck's theory of a growth mindset. Bandura's theory of self-efficacy is a social cognitive theory, based on the belief that one can achieve his or her goals (Bandura, 1977). Expanding upon self-efficacy is growth mindset, the belief that one may improve through engagement with the learning process (Dweck, 2006). Researching first-generation, low-income, student of color college success framed within self-belief will investigate the potential influence on math completion. This premise offers great possibilities for institutions to take action in creating an environment that promotes self-belief in developing the talent of first-generation, low-income, students of color to hopefully be successful in math and empower their collegiate success.

Definition of Terms

To provide a background for definitions of this study, the rationale for identified identities and varying definitions for first-generation, low-income, and ethnicity are illustrated. Based on this analysis, the chosen definitions of first-generation, low-income, ethnicity, and mathematics are outlined below.

First-Generation, Low-Income, Students of Color, and Mathematics

This study intentionally focuses on first-generation, low-income, students' of color identities, as those identities that have demonstrated graduation gaps when compared with continuing generation, higher income, and White students. It is important to acknowledge the

vast diversity of perspectives and experiences within first-generation, low-income, students of color, as well as other identities, such as gender and sexual orientation, along with the intersectionality of various identities influencing the unique experiences of each individual (Jones & Abes, 2013) not fully accomplished in this study. The determination to focus on three identities, first-generation, low-income, and ethnicity, was not utilized to eliminate other identities, but to define a reasonable research scope with three identities that have demonstrated lower college graduation rates. Additionally, utilizing both first-generation and low-income identities is necessary, since many studies reference first-generation and low-income as if they were one category (Davis, 2010; Martin, 2012).

First-generation. For the purpose of this study, first-generation students are defined, using the TRIO definition, as students whose parents have not obtained a college degree (Nunez, Cuccaro-Alamin, & Carroll, 1998). This definition is different than the National Center for Education Statistics classification, which defines first-generation students as having parents with no postsecondary education. The dissimilar definitions create a big variance in numbers. For instance in 2011-2012, the percentage of first-generation students attending higher education institutions is 61.6% with parents with a high school diploma or less, and 33.5% with parents without a bachelor's degree (National Center for Education Statistics, n.d.).

Along with these two definitions, a couple of studies in the literature review utilized other definitions, such as at least one parent born outside the United States (Alessandria & Nelson, 2005), or parents with no associate or bachelor's degree (Aspelmeier, Love, McGill, Elliott, & Pierce, 2012). Although it makes some sense to align with the National Center for Education Statistics definition, using first-generation students whose one or both parents have not obtained

a bachelor's degree was utilized for this study, since it is predominately used in most research studies reviewed.

Low-income. The definitions for low-income students within the literature reviewed varied, including Pell Grant eligibility (Lourdes, 2015; Martin, 2012), self-identified low social economic levels (Benson, Hewitt, Heagney, Devos, & Crosling, 2010; Garrison & Gardner, 2012), combination of parent income level and student perception of social class (Lin, 2011), working class parents or guardians in occupations with lower levels of skills, lower pay, and limited autonomy (Stuber, 2011), and below poverty level by qualifying for free or reduced lunches (Reid & Moore, 2008). Additionally, Pizzolato (2003) research study utilized students from support programs that may have income level requirements, although this was not explicitly stated in the research. Consequently, the definitions of low-income were even more diverse than first-generation classifications.

This study defines low-income as students who are Pell Grant Eligible. Pell Grants are government grants for college students with exceptional financial need (Dynarski & Scott-Clayton, 2013). Eligibility for the federal grant is commonly used as a proxy for low-income status, since the majority of recipients (73% of dependent maximum grant recipients and 90% of independent maximum grant recipients) have annual family incomes of \$20,000 or less (Cook & King, 2007). Pell Grant Eligibility is also a common variable at higher education institutions across the country reported as part of the National Center of Educational Statistics data.

Students of Color. People of color or students of color, is a term primarily used in the United States and Canada to describe any person who is not White, emphasizing the common experiences of systemic racism. This term has replaced minority, which suggests a deficiency and is not true numerically in many places across the country. For some, the positive aspects of

students of color can create solidarity of underrepresented groups, and be inclusive of a variety of racial and ethnic identities.

Issues with students of color terminology is it continues to place White at the top of the racialization hierarchy, silos White people and people of color, and places all people of color into one category, an issue for some people who have a stronger connection with their country of origin (Moses, 2016). Despite the complexities of students of color terminology, this term is used for this study, since it encompasses a variety of ethnicities and currently is a commonly used term in higher education.

Mathematics. In preparation for taking college math, the math placement processes will be examined. The specific mathematics courses of interest for this research are college level pre-calculus, and first year calculus usually required for students majoring in science, technology, engineering, and math (STEM) areas.

Summary

In summary, the purpose of this study is to explore first-generation, low-income, students' of color experiences with math placement and pre-calculus/calculus math courses. More specifically, this study focuses on how university factors influence the self-belief of first-generation, low-income, students of color to be successful in math. This research may provide insights on how emphasizing self-belief can enhance math completion.

Dissertation Overview

Chapter 2 provides an overview of the literature on first-generation, low-income, students of color characteristics and college outcomes, along with initiatives to support these students. The theoretical framework of stereotype threat and self-belief, and the relationship of self-belief and math achievement provide the context to research first-generation, low-income, students' of

color math experiences. Chapter 3 describes this qualitative case study as part of the Progress Through Calculus research, with more specific details about case study identification, participants, data collection, data analysis procedures, trustworthiness criteria, delimitations, and limitations.

Chapter 4 illustrates the case studies' findings, beginning with institutional context and student profiles. Themes from these first-generation, low-income, students' of color college experiences illustrate both appreciation and pressure for having the opportunity to attend college, along with a strong connection with family. The framework to describe these students' experiences begin with the math placement process and continue with the academic year in pre-calculus/calculus courses. The math placement process, as one of the first experiences with students in college, revealed anxiety with this high stakes exam, and was viewed with a fixed mindset. The findings from students' experiences in math focus on the transformation as engaged learners. The university factors that influenced students' self-belief to be successful in math are illustrated within inclusive pedagogies in the classroom, and support structures to enhance student learning.

Chapter 5 integrates the findings from this study with related literature within the self-belief theoretical framework. Implications for practice are illustrated to improve the math placement process, empower students to become transformed learners, create more inclusive classrooms, and provide support structures to promote student learning and success. Illustrating the findings of this research holistically in a way that higher education can comprehensively move forward to improve the success in pre-calculus/calculus courses, this study integrates engaged learning, inclusive pedagogies, and support structures together as a community

approach to learning. Finally, Chapter 6 provides the strengths and limitations of the study, recommendations for future research, and reflections on my research journey.

CHAPTER 2: LITERATURE REVIEW

This literature review focuses on the characteristics and collegiate outcomes for first-generation, low-income, students of color, and illustrates ways higher education attempts to promote their college success. The characteristics of these underrepresented students focus on family, academic, psychosocial, and cultural aspects. In each category, the more prominent deficiencies are summarized which are problematic ways to frame first-generation, low-income, students of color. Second, but more importantly, research on the assets of first-generation, low-income, students of color challenge these deficit perspectives.

Despite the literature findings on the assets of first-generation, low-income, students of color, their collegiate outcomes demonstrate continued graduation gaps when compared to other students. Studies that research ways to close first-generation, low-income, students' of color graduation gaps are reviewed, including promotion of a culture where students can thrive. Next, the theoretical framework of stereotype threat and self-belief is illustrated along with how self-belief impacts both academic achievement and math achievement. Finally, a methodological analysis of a subset of the research on first-generation, low-income, students of color informs the research design of this study. Research on first-generation, low-income, students of color combined with self-belief and math achievement provide a context for this study on student perceptions of their experiences in mathematics.

First-Generation, Low-Income, Students of Color Background

Colleges have transitioned from educating a fairly homogenous elite group of White male students to educating a much more diverse group of students, including first-generation, international, veteran, low-income, and ethnically diverse students (Kezar, 2001). Considering first-generation students, even though they have been attending college in larger numbers since

the GI Bill approximately 70 years ago, as higher education institutions have become more aware of the inequalities of educating diverse students, a new formalized category of first-generation students has emerged. Currently, a majority of higher education institutions talk about first-generation students, but generational status is still an emerging identity, since higher education practices to assist first-generation students have not been well defined (Davis, 2010). Additionally, some students do not know what it means to be a first-generation student and consequently may not acknowledge this identity.

Unlike first-generational status, low-income students are keenly aware of this underrepresented identity and more low-income students are part of our educational systems. For instance, low-income high school graduates doubled from 26% in 1972 to 54% in 2005 (National Center for Education Statistics, 2007). To assist with the financial needs of these students and provide a mechanism to decrease loan debt, Pell Grants were implemented as part of the Higher Education Act of 1965, which meant students did not have to repay these funds (Mahan, 2011, May 12). Additionally, the Higher Education Amendment of 1980 strengthened and improved student loan programs to continue to promote access to higher education (Govtrack, 2017).

Along with low-income college students, the number of students of color is increasing on college campuses. According to Musu-Gillette et al. (2016, August), students in the racial/ethnic groups of Black, Hispanic, Asian, Native Hawaiian or Other Pacific Islander, Native American/Alaska Native, and multiracial are enrolling in college in increasing numbers. Despite these gains, the graduation rates vary among these racial/ethnic groups. The percentage of adults age 25 and older, who had earned at least a bachelor's degree in 2013 by ethnicity were Asian (52%), White (33%), Multiracial (32%), Black (19%), Pacific Islander (16%), Native American/Alaska Native (15%), and Hispanic (14%).

Even though the government and higher education institutions provide programs targeted to serve first-generation, low-income, students of color, such as TRIO Programs, best institutional practices to assist these students often have not been developed. More research is needed to gain a better understanding of how higher education institutions can provide enhanced support for first-generation, low-income, students of color.

First-Generation, Low-Income, Students of Color Characteristics

To gain a more in-depth understanding of first-generation, low-income, students of color, the general characteristics are described by family, academic, psychosocial, and cultural characteristics, acknowledging these characteristics do not fully illustrate the diversity and uniqueness of these students. This summary first shares more prominent research focusing on deficits as a disadvantage to being successful in college. Examples of what is seen as disparities include a lack of parental support for first-generation students (Ward, 2012), less curricular and co-curricular college engagement for first-generation (Pascarella, Pierson, Wolniak, & Terenzini, 2004), and low-income students (Warpole, 2003), not as much social capital for first-generation, low-income, students of color (Lin, 2011), and a cultural mismatch with the university for first-generation students (Stephens, Fryberg, Markus, Johnson, & Covarrubias, 2012). Second, although not as prevalent, research within an asset framework as an advantage for collegiate success focus on self-authorship for first-generation, low-income students (Pizzolato, 2003), high motivation to attend college for first-generation, low-income, White students (Martin, 2012), and a desire to contribute to society with first-generation, students of color (Olive, 2009) will also be summarized.

Family Characteristics

The prominent view of first-generation, low-income, students of color is their family background is a shortfall illustrated with less emotional and financial support. However, some studies illustrate evidence for parental support and involvement, but perhaps in a different approach than given by college educated parents.

Deficits. Most studies indicate first-generation, low-income, students' of color family attributes negatively influence their college experience. For instance, Ward (2012) shares first-generation students have less parental support, both financially and emotionally. Lohfink and Paulsen (2005) found first-generation students with fewer grants and less work study funds had lower levels of persistence than other students. Additionally, low-income students must work more, leaving less time for college engagement experiences compared to higher income students (Warpole, 2003). Pertaining to emotional support to pursue higher education, Benson et al. (2010) shared although first-generation, low-income, students of color had general support from their families, limited guidance adversely influenced their education.

Assets. Family characteristics that positively impact first-generation students are siblings who attended college, residence, and speaking two languages. For instance, Shields (2002) found first-generation students with a sibling who attended college had increased credit completion, which may be related to persistence. However, more research is recommended to determine if siblings completing college impact graduation rates of first-generation students. Students living at home were 18.3% more likely to persist in college than first-generation students not living at home (Lohfink & Paulsen, 2005). Conversely, Pike and Kuh (2005) reported students who lived on campus had higher levels of engagement. Finally, first-generation, students of color who spoke a language besides English at home appeared to persist

at higher rates than English-speaking students (Lohfink & Paulsen, 2005), and the family support of Latino students positively influenced academic self-efficacy (Torres & Solberg, 2001). New replicated studies to reexamine family characteristics along with gathering more in-depth information about how these characteristics impact persistence and graduation are recommended, since this research was done over ten years ago.

Even though parents provided limited guidance, Aspelmeier et al. (2012) found, in general, most first-generation students felt supported by their families. This finding was also echoed by Bishop (2008), who found parental support was similar with first-generation and continuing generation students with no differences in parental influence on students' beliefs they would succeed in college.

Pertaining to family expectations about the college experience, Shields (2002) found first-generation students' parents had a more hands-off approach to the college experience, resulting in first-generation students not experiencing the stress of family expectations to the same extent as continuing-generation students. On the other hand, according to Jehangir, Stebleton, and Deenanath (2015), first-generation, low-income students felt pressure of succeeding and honoring family expectations, and highlighted that parents were integral and involved in their student's college experiences. According to the students, they received family support, regardless of whether the family members attended college. More in-depth research to explore the overall family support of first-generation, low-income, students of color within an asset framework may provide a greater understanding of the unique and perhaps positive aspects of their family support.

Academic Characteristics

Much of the research points to academic deficiencies of first-generation, low-income, students of color, such as less collegiate preparatory coursework, fewer math courses, undeveloped student success skill sets, less academic and co-curricular engagement, and lower educational aspirations. However, first-generation, low-income, students of color engaged in academic and co-curricular experiences in college have demonstrated positive influences on collegiate success. This research suggests more university initiatives are needed to encourage academic engagement with these students.

Deficits. One area of research focused on academic deficiencies of first-generation, low-income, students of color is with preparatory coursework prior to college. Based on the 2000 National Assessment of Educational Progress in math, scores were lower for Black, Hispanic, and Native American students compared to White and Asian/Pacific Islander students in grades four, eight, and twelve (Braswell et al., 2001, August). Chen and Carroll (2005) found first-generation students enrolled in postsecondary education between 1992 and 2000 needed more remedial courses (e.g. 40% of first-generation students took remedial math compared to 16% of continuing-generation students), and Reid and Moore (2008) reported first-generation students lacked academic skills in math and science coursework. These findings were reinforced by a more recent study that examined mathematics SAT scores for 6,280 first-year students from 1999 to 2009. Atherton (2014) found the odds of scoring above the median were 38% higher for students with two parent graduates compared to first-generation students.

Lower levels of math completion. Considering math coursework in high school, Musu-Gillette et al. (2016, August) reported the percentages of students taking calculus in high school was 6% for Black students, 10% for Hispanic students, and 11% for multiracial students, which

are much lower than White students (18%) and Asian students (45%). Focusing on math courses in college, an analysis of first-generation student college transcripts from 1992 to 2000 shared 55% of first-generation students took at least one math course in college compared to 81% of students whose parents had a bachelor's degree (Chen & Carroll, 2005). Additionally, at Colorado State University (2016), after controlling for prior academic preparation, first-generation, students of color, and Pell grant recipients were significantly less likely to place into college algebra and complete the general education math requirement during the first year compared to their peers. This suggests there may be other issues influencing math completion.

Research illustrates a connection between college math completion and graduation. For instance, according to Adelman (2006), 71% of students who took math by the end of the second year in college graduated, compared to 38% of students who did not take math during their first two years.

Student success skills deficits. Pertaining to skills necessary to be a successful student, Collier and Morgan (2008) discovered perhaps first-generation students were not as adept at mastering the student role; consequently, fulfilling faculty expectations compared to continuing-generation students. These findings were based on lower levels of cultural and social capital or preexisting knowledge of how to interact in academic settings. Additionally, research has shown first-generation, low-income, students of color may need better study skills for college-level work and had poor time management skills prior to college (Reid & Moore, 2008). It is worth noting that Reid and Moore focused only on first-generation, low-income, students of color, and the need for improved time management and study skills may also be issues for other students.

Less college engagement. Beyond student skill sets, there may be less engagement in college with first-generation, low-income, students of color. Focusing on first-generation

students, Pascarella et al. (2004) analyzed longitudinal data from 18 four-year colleges and found lower levels of academic (e.g., course related peer interaction, credit completion, study time) and co-curricular (e.g., campus activities, volunteering, non-course peer interactions) engagement in college compared to continuing-generation students. This finding was mirrored in a more recent study that found less academic engagement with first-generation students measured by faculty interactions, and contributions to class discussions (Soriaa & Stebleton, 2012).

Regarding low-income students, Warpole (2003) found students work more, study less, and are less involved, than higher-income peers. Research specifically studying academic engagement found low-income students did not experience faculty contact and active learning at the same levels as higher-income students (Goodman et al., 2006). Lower engagement rates for students of color has been attributed to a campus environment that does not embrace ethnically diverse students (Harper & Hurtado, 2007). Since active engagement in college is a key to student success (Kuh et al., 2006), lower levels of engagement by first-generation, low-income, students of color may be a detriment to their collegiate experience.

Lower educational aspirations. Concerning aspirations of obtaining a college degree, studies of Latino students are interesting in that one study showed Latino parents of high school seniors place nearly twice as much emphasis on the necessity of a college education for success compared to African American and White parents (Immerwahr, 2000). Another study Swail, Redd, and Pema (2003) found more White students (79%) aspired to a postsecondary degree compared with Latinos (63%). Regarding long-term educational aspirations, Pike and Kuh (2005) shared first-generation student participants were not as interested in obtaining an advanced degree when they entered college compared to non-first-generation students. Warpole (2003) found low-income students had lower levels of graduate school attendance nine years

after beginning college compared to higher-income peers. This may relate to findings that although low-income students have a desire to further their education, obstacles get in the way of obtaining this goal, which could be the dependence on financial earning (Adair, 2001). This literature may demonstrate academic disparities found prior to, during, and after college for these students.

Assets. Academic factors that helped first-generation students with college success include high school courses, valuing academic success, and engaging in the collegiate experience. Although adequate course preparation is not an overall strength of first-generation students, based on qualitative studies taking Advanced Placement courses, especially English, positively impacted collegiate success of first-generation students (Holodick-Reed, 2013; Reid & Moore, 2008). Additionally, Ishitani (2003) found first-generation students' high school math completion had a positive impact on higher levels of college attendance. Students' value of academic success was also an asset for these students. For instance, McCarron and Inkelas (2006) reported first-generation students' perceptions of the importance of good grades were a predictor of educational aspirations in college.

Regarding engagement, even though first-generation students had lower levels of academic and co-curricular engagement in college, their engagement showed greater benefits on critical thinking and internal locus of control with academic success than non-first-generation students (Pascarella et al., 2004). Additionally, Lohfink and Paulsen (2005) found first-generation student participants, who had higher levels of academic engagement focusing on faculty-student interaction, persisted in college at higher rates than students with lower levels of academic engagement. Considering student engagement for Black males, high achieving Black males were all extensively engaged on their campuses participating in study abroad programs,

internships, service learning, and summer research programs (Harper, 2012). Finally, National Survey of Student Engagement (NSSE) results show, in general, students from different racial and ethnic backgrounds appear to engage in effective educational practices at comparable levels (Kuh et al., 2006). Additional research on first-generation, low-income, and students of color engaged in college is recommended, since these experiences potentially have a positive influence.

Psychosocial Characteristics

Research is mixed when looking at first-generation, low-income, students of color and self-efficacy. However, this research is fairly consistent that lower levels of a sense of belonging and a social network exist with these students. Perhaps the assets of self-authorship, motivation, and effective coping strategies of first-generation, low-income, students of color provides some resilience to deal with the lack of connection with higher education institutions.

Deficits. Research findings of psychosocial deficiencies for first-generation, low-income, students of color include less social capital, self-efficacy and sense of belonging, and a lack of a support network. According to Ward (2012), social capital or having the knowledge to succeed in college appears lacking for first-generation students. This finding was reinforced for first-generation, low-income, students of color with lower levels of social capital (Lin, 2011).

Lower self-efficacy. Less social capital may relate to research that first-generation, low-income students of color participants had lower self-efficacy, which is one's belief that he or she can achieve his or her goals, than White, continuing-generation, higher income students (Lin, 2011). Ramos-Sanchez and Nichols (2007) similarly found that first-generation students had lower levels of self-efficacy than continuing generation students. Supplementary studies related to self-efficacy found that first-generation students had a greater fear of failing than continuing-

generation students (Bui, 2002), noting that the comparison groups in this study were fairly unequal with first-generation students in a collegiate success program compared to students in an introductory psychology course. Additionally, low-income college students felt inadequate and powerless especially at elite institutions (Aires & Seider, 2005). The lack of knowledge about the college experience for first-generation, low-income, students of color may influence their self-belief for success in college.

Less sense of belonging. According to Strayhorn (2012), a sense of belonging is defined as students feeling supported, connected, cared about, and respected in college. Beyond social capital and self-efficacy, there may be less of a sense of belonging in college for first-generation (Ward, 2012) and low-income students (Aires & Seider, 2005). A lack of belonging may be the result of feeling alienated for first-generation students (Ostrove & Long, 2004), socially isolated for first-generation, low-income, White students (Martin, 2012), or being strongly connected with family and friends not experiencing higher education for White first-generation students (Stuber, 2011). According to Strayhorn (2008), Latino students had less sense of belonging than White students, however Latino students increased their sense of belonging with good grades, more time spent studying, and interactions with diverse peers. The lack of a sense of belonging in college is of heightened importance for individuals who may feel unwelcomed and unsupported (Strayhorn, 2012).

Lack of a support network. Not only do first-generation, low-income, and students of color feel less knowledgeable, engaged, and connected to their collegiate experience, research shares these students have less support from others, both in and outside higher education. For instance, Lin (2011) shared first-generation, low-income, minoritized students self-reported lower levels of support from family, friends, and mentors compared to continuing-generation,

higher-income, White students. Additionally, the lack of peer support was a negative predictor of college adjustment for first-generation students of color with lower grade point averages during the first year, spring semester (Dennis, Phinney, & Chuateco, 2005).

The lack of a support network, especially among first-generation college students, may impact imposter syndrome or present self-doubt about their ability to be successful (Davis, 2010), therefore, not sharing their first-generation status. For instance, Orbe (2004) found first-generation students were not connected with each other, in spite of having a similar first-generation identity. Additionally, first-generation students were less likely to disclose their college experiences than non-first-generation students (Barry, Hudley, Kelly, & Cho, 2009). Steinmetz (2008) found low-income students mask their social class identity. Some of the psychosocial disparities of less self-efficacy, sense of belonging, and not sharing one's identity could be based on stereotype threat, where negative expectations for one's performance, based on social group, can place individuals at risk of lower performance (Steele, 1997).

Assets. Psychosocially, although most of the literature too often states the psychosocial deficits of first-generation, low-income, students of color, some research findings point to psychosocial assets. These positive attributes to college success include self-authorship, self-belief, resilience, motivation, responsibility, and effective coping strategies.

Self-authorship. According to Baxtor (2009), self-authorship is the transition from an external focus of relying on others to define oneself to more internal thinking in determining one's life path. This internal approach of self-authorship was demonstrated by first-generation, low-income students in the college application process with parents unable to offer advice, thereby requiring students to create their own formulas for success (Pizzolato, 2003).

Self-belief. Related to self-authorship, self-belief affirms one can achieve goals. Olive (2009) researched first-generation Hispanic students' desires to attend college. She identified self-efficacy and goal orientation in past academic endeavors, as well as self-discipline in pursuing goals. An aspect of self-belief is self-esteem, which Aspelmeier et al. (2012) found to be more predictive of better first year adjustment with first-generation than continuing-generation students.

Although first-generation was defined differently than most research with at least one parent born in a country outside the United States, first-generation students of color representing all four years of college had significantly higher levels of self-esteem than continuing-generation students (Alessandria & Nelson, 2005). These findings could have been influenced by parents' high self-esteem to leave their home country and migrate to the United States. These studies emphasize the self-belief of first-generation, low-income, students of color, conflict with Lin's (2011) research on less self-efficacy of these students.

Other research related to self-belief includes Garrison and Gardner (2012), where first-year, first-generation, low-income students shared personal attributes, such as goal direction with purposeful lives, self-reliance, and optimism in working toward goals. Additionally, Phinney and Haas (2003) interviewed first-year first-generation students of color with both high and low levels of self-efficacy and found students reporting a greater sense of self-efficacy were more successful in coping with stress. Finally, Bishop (2008) found no differences between first-generation and continuing generation students, and self-efficacy related to parental influences.

Resiliency. Along with self-belief, self-rated resiliency has been found with first-generation students of color. For instance, Komada (2002) found statistically significantly higher resiliency for first year, first-generation students compared to continuing generation

students defined by ratings in self-esteem, spirituality, high expectations of self, and negative early educational experiences than their peers. Additionally, high achieving African American college student perspectives on resiliency included parenting practices that focused on school, personal stories of hardship, positive mother–child relationships, extended family networks, supportive school-based relationships, school-oriented peer culture, good teaching, extracurricular school activities, social support networks, and out-of-school time activities (Williams & Bryan, 2013).

Most of the research on self-belief has been focused prior to or at the beginning of the collegiate experience (Aspelmeier et al., 2012; Garrison & Gardner, 2012; Olive, 2009; Phinney & Haas, 2003; Pizzolato, 2003; Williams & Bryan, 2013), with one study including freshman through senior first-generation students (Alessandria & Nelson, 2005). More understanding of self-belief throughout the college experience, which may become stronger the longer students are in college, would be beneficial.

Motivation and responsibility. Along with self-belief, studies have researched motivation and responsibility as positive attributes of first-generation college students. More specifically, Prospero and Vohra-Gupta (2007) shared intrinsic motivation of going to college, such as the love of learning, was a significant predictor of academic achievement of first-generation students. Related research shows first-generation, low-income, students of color reporting higher perceived motivation to attend college compared to continuing-generation, higher-income, White students (Lin, 2011).

Pertaining to responsibility, Pascarella et al. (2004) found third-year, first-generation students had a higher internal sense of responsibility of academic success than continuing-generation students. Stuber (2011) shared sophomore and junior first-generation low-income

students became independent and responsible, and appreciated their accomplishments because of their background. Martin (2012) also found first-generation, low-income, White students, who had completed at least two semesters of college, reported ethics of hard work, self-sufficiency, and financial responsibility. It is interesting to note the research on responsibility focused on students who completed at least their first year of college, which is after the largest number of students leave higher education institutions (National Center for Education Statistics, 2002). Additional research focusing on first-generation, low-income, students' of color perceptions of responsibility at the beginning their college experience would perhaps provide more comprehensive insights.

Effective coping strategies. Another psychosocial attribute that positively influences college success is effective coping strategies when facing challenges. Personal attributes, such as flexibility in adapting to changing circumstances, persistence, and reflexivity (e.g., insightfulness and balance), influenced first-generation, low-income students' ability to address challenges and achieve goals (Garrison & Gardner, 2012). Additionally, first-generation Hispanic students' experiences overcoming adverse circumstances in college were opportunities to demonstrate resilience, self-discipline, and motivation (Olive, 2009). In a four year longitudinal study with 3,290 college students, first-generation students were less likely to experience psychological distress and use drugs and alcohol than continuing generation students (Martinez, Sher, Krull, & Wood, 2009). Focusing on junior and senior first-generation low-income students, Jehangir (2010) shared that despite having to navigate between different cultures of school and home, and often feeling underrepresented, students gained confidence and engaged in the college experience.

Cultural Characteristics

Cultural incongruence between home and school is well-documented for first-generation, low-income, students of color. However, cultural support was determined instrumental to enhance their collegiate success.

Cultural incongruence. Stemming from family, academic, and psychosocial disparities, first-generation, low-income, students of color may experience conflicting values in college regarding family and collectivism. For example, first-generation students had conflicting emotions about parents, feeling like an ‘outsider,’ especially with friends who did not go to college. Additionally, they were conscious of financial differences and deficiencies in cultural capital with college peers (Roberts & Rosenwald, 2001). Similarly, first-generation, low-income, students of color perceived their personal and home values as incongruent with higher education’s values, especially at elite institutions, which may be the clash between students’ collectivist approach compared to institutions’ focus on independence and personal gain (Lin, 2011). One of these cultural differences could be the disconnect between parents’ and first-generation students’ expectations on the value of getting a job versus the value of learning (Stuber, 2011). It is important to note that low-income students’ struggles with class-based discontinuities evolved and changed during their college experience, as they gained more cultural capital and more effectively coped with class differences (Aires & Seider, 2005).

Cultural support. To mitigate cultural incongruence, a strong network of family members who provide holistic support, faculty who care and have high expectations, and peers who offer encouragement help first-generation college students’ transition to college (Coffman, 2011). In turn, this support helps first-generation, students of color to obtain a college degree (Lourdes, 2015). Supplemental research found many of the challenges first-generation Hispanic students

faced in college were countered by encouragement from family members and interactions with faculty, which enhanced intellectual curiosity, academic potential, and increased autonomy (Olive, 2009). Additionally, Harper (2010) found same race peers were critical to Black students' sense of belonging and success in STEM courses at institutions across the country.

The importance of cultural support has been found with low-income students, revealing that what mattered most was the intervention of at least one adult mentor at crucial times in their lives, such as going to college (Levine & Nidiffer, 1996). More broadly, a sense of belonging mediated lower social class students' feelings of alienation in college (Ostrove & Long, 2004).

Building upon students' strengths of self-authorship, self-belief, and the ability to effectively cope with challenges in college is the power of having a strong support network to assist students in their collegiate success. Even more impressive within a broader societal perspective is first-generation, students' of color desire to break from family circumstances without postsecondary education, possess a need to contribute to society, and uphold an altruistic motivation to provide assistance to their family (Olive, 2009). More broadly, Yosso (2005) discusses the cultural and social assets of students of color, including having aspirations for the future, skills in another language or communication style, commitment to community, social networks, navigation of social institutions, and resistance to inequalities. These assets benefit first-generation, low-income, students of colors' college experiences as well as institutions benefiting from these qualities incorporated in classrooms and co-curricular experiences across campus. If institutions can empower these strengths and enhance support for first-generation, low-income, students of color, perhaps graduation gaps will begin to shrink.

College Outcomes for First-generation, Low-income, Students of Color

Expanding beyond the characteristics of first-generation, low-income, students of color, their collegiate successes have been measured in terms of enrollment patterns, academic outcomes, persistence rates, and graduation trends. Unfortunately, there are clearly demonstrated gaps between first-generation, low-income, and students of color compared to continuing-generation, higher-income, White students in all of these areas.

Enrollment Patterns

Regarding enrollment patterns, in a ten-year longitudinal study, first-generation students were 70% less likely to enroll in a four-year college than non-first-generation students (Wilbur & Roscigno, 2016). Additionally, first-generation students were less likely to continuously enroll at their initial postsecondary institution than continuing-generation students (National Center for Education Statistics, n.d.). First-generation students were also more frequently part-time compared to continuing-generation students (Nunez et al., 1998), knowing that part-time students have lower graduation rates than full-time students (National Center for Education Statistics, 2012, March).

In 2013, the total college enrollment rate for White 18- to 24-year-olds was (42%) compared to Black and Hispanic students (34% each). The White-Hispanic gap in college enrollment rate narrowed between 2003 and 2013 from 18 to 8 percentage points. However, the White-Black enrollment gap did not change (Musu-Gillette et al., 2016, August). Finally, low-income students have more enrollment gaps, which are also longer compared to higher income students (Goldrick-Rab, 2006).

Academic Outcomes

Expanding on enrollment patterns, outcomes during college include grade point averages and skills in math, reading, and critical thinking. Chen and Carroll (2005) found first-generation students received lower grades than continuing-generation students. More specifically, first-generation students had lower math grades than continuing-generation students (Katrelich & Aruguete, 2017). With low-income students, Warpole (2003) found those who attend four-year colleges report lower grade point averages. Grades have been shown to relate to persistence as a higher first-year grade point average positively impacted first-generation students persistence (Lohfink & Paulsen, 2005). Although assessed a bit differently, comparing cumulative grade point averages of those with bachelor's degrees by ethnicity in 2007-2008, 5.5% White graduates had a grade point average of 2.5 or below compared to approximately 8% for Hispanic and Asian graduates, and 15% for Black graduates (National Center for Education Statistics, 2012, October).

Researching cognitive outcomes of first-year, first-generation students, Padgett, Johnson, and Pascarella (2012) suggest they are at a significant disadvantage with cognitive outcomes, such as the desire for lifelong learning and writing capabilities. Other outcomes not as dramatic include Pike and Kuh (2005), who found fewer gains in intellectual development (i.e., gains in general education, communication skills, and interpersonal development on the College Student Experiences Questionnaire) compared to continuing-generation students. They noted these differences were small and self-reported.

On the other hand, when comparing first-year, first-generation college students and non-first-generation college students' academic experiences at 23 diverse institutions, first-generation and non-first-generation students gained similarly in math and critical-thinking skills (Terenzini,

Springer, Yaeger, Pascarella, & Nora, 1996). Additionally, longitudinal studies from Shields (2002) revealed no significant differences between a random sample of first-generation and continuing-generation, second-year students on writing skills, reading comprehension, and critical thinking. Considering collegiate experiences, third-year, first-generation students had a significantly higher preference for complex cognitive tasks than continuing-generation students. It should be noted that findings on cognitive skills are more positive for first-generation students in their third year compared to first-year students, suggesting skills can be gained when practiced.

When considering ethnicity and math scores in high school, the mathematics scores for White twelfth graders were higher than the scores for their Black and Hispanic peers in 2005, 2009, and 2013. There were no measurable changes in White-Black and White-Hispanic mathematics achievement gaps at grade twelve between any of these years (Musu-Gillette et al., 2016, August). According to the National Study of Student Learning in 1992-1995 with college students at 23 institutions, students of color in community colleges had higher rates of reading comprehension and math compared to White students. Additionally, first year gains in critical thinking were found for all students, but were most profound for Latino students (Pascarella, 2001).

Retention and Graduation Rates

Regarding retention and graduation rates, lower first to second-year retention and six-year degree completion rates were found with first-generation, low-income, students of color. Data from the National Center for Education Statistics (2007) with 4.5 million college students reported low-income and first-generation were approximately four times as likely to leave college after the first year compared to continuing-generation, higher-income students. Among

college students from 1995-2002, six-year graduation rates for first-generation low-income students were 44% lower than continuing-generation, higher-income students (Engle & Tinto, 2008). Additionally, according to the National Center for Education Statistics (2010, July), slightly over half of the degrees earned in 2008 were Whites (53%) and Asians/Pacific Islanders (54%), compared to lower percentages for Hispanics (48%), Blacks (47%) and Native American/Alaska Natives (46%).

Programmatic Approaches to Enhance Collegiate Success

To promote collegiate success for first-generation, low-income, students of color, research has investigated specific initiatives to support these students, including federally-funded support programs. Additionally, student success initiatives that benefit all students, with particular benefit for first-generation and low-income students, have been studied.

Programs Focused on First-generation, Low-income, and Students of Color

Specific programs encouraging the collegiate success of first-generation, low-income, students of color include federally-funded TRIO programs that assist with college preparation, such as Upward Bound, Talent Search, and Bridge, along with Student Support Services during college (Holodick-Reed, 2013). These programs can create meaningful connections and are acknowledged as extremely instrumental in transitioning to college (Jehangir et al., 2015). Another program that can improve the experiences of first-generation students at higher education institutions are learning communities, which create community and provide a voice for first-generation students (Jehangir, 2010). Other initiatives include increasing faculty and staff knowledge of first-generation students, providing targeted orientation programs, and advising first-generation students on a wide variety of academic and career options (Ward, 2012). These

initiatives have proven successful by providing a supportive environment with additional assistance to help students navigate the college experience.

Culture Supporting First-Generation, Low-Income, Students of Color

Building on specific initiatives for first-generation, low-income, students of color are broader interventions that focus on creating an institutional culture to support these students' successes. This supportive culture is promoted by emphasizing interdependence and acknowledging how students from various backgrounds can be successful in college. Regarding an interdependent culture, Stephens et al. (2012) found first-generation students identified with an interdependent culture (i.e., the institution is supporting students to be successful) rather than an independent culture (i.e., student success is up to the student), common of most higher education institutions. By integrating an interdependent culture of being part of a community through university orientation materials, scores on verbal and visual spatial tasks were similar for first-generation and continuing-generation students compared to a control group (independent cultural emphasis), where first-generation students' scores were lower than those for continuing-generation students.

Another cultural intervention focused on acknowledging social backgrounds of incoming, first-generation students by providing a senior student panel telling stories about their college experiences linked to social class backgrounds (Stephens, Hamedani, & Destin, 2014). First-generation students, who participated in the education panels, were statistically significantly higher in acknowledging that students with backgrounds similar to theirs can succeed, compared to students who did not participate in the intervention. Additionally, after controlling for pre-existing differences in student demographics and academic skills, first-generation student

participants had higher first-year cumulative grade point averages and greater use of college resources than first-generation students in the control group.

These psychosocial interventions have been broadened to include other strategies that have had similar results for low-income students in high school at both public and private higher education institutions. Interventions included transition surveys in high school about going to college, and written summaries and reflections about transitions completed prior to beginning college. Results illustrated higher percentages of full time enrollment, higher grade point averages, greater use of resources and development of social networks for these students than the control groups (Yeager et al., 2016). Another writing intervention focused toward first-generation students taking an introductory biology course, using values affirmation writing exercises for students to talk about what they were good at accomplishing, and values important to them as part of the lab experience. First-generation students who participated in the study had higher grades than first-generation students in the control group. Continuation to other biology courses was also higher for first-generation than continuing generation students (Harackiewicz et al., 2014).

Stephens et al. (2012), Stephens et al. (2014), Yeager et al. (2016), and Harackiewicz's et al. (2014) research represent a paradigm shift from most of the studies focusing on how to support first-generation, low-income, students of color in adapting to the institutional culture, to research how institutions can make adaptations to enhance the success of first-generation, low-income, students of color. This concept of supporting students who attend college rather than requiring students to adapt to college, has been defined as becoming a student-ready college (Brown McNair, Albertine, Cooper, McDonald, & Major, 2016).

Overall Student Success Initiatives

In addition to specific programs or institutional approaches to enhance first-generation, low-income, student of color success, strategies to enhance collegiate success for all students, including first-generation, low-income, and students of color are orientation, first-year seminars, living on campus, learning communities, early warning systems, and enhanced academic advising (Kuh et al., 2006). Additionally, learning analytics or data-driven decision-making is a tool that helps many colleges identify and implement strategies to improve retention (Picciano, 2012).

One example of a learning analytic finding that impacts graduation is early math completion. As mentioned earlier, students who complete at least three credits of math during the first year in college had higher graduation rates than those students who did not complete math (Adelman, 2006; Colorado State University, 2015a). This learning analytic knowledge that connects math completion and graduation informs the focus on math experiences for this research.

Stereotype and Self-belief Theories

To frame the characteristics and outcomes of first-generation, low-income, students of color, the theoretical scaffold of this study is structured within the power of positive psychology and potential influence on math completion. Theories to inform this framework are stereotype threat (Steele, 1997), which challenges college success, and self-belief (Bandura, 1977; Dweck, 2006), which can potentially mediate challenges and promote academic success. Combining this positive framework with psychological models that influence students' experiences in college, culminate in a concept called thriving, where students are meaningfully engaged in college. Thriving is a holistic approach with cognitive and psychosocial components, using a strength

development model to empower students to apply their strengths in responding to college transitions and challenges, and to be part of and contribute to their collegiate community (Schreiner et al., 2012).

Stereotype Threat

In thinking about the graduation gaps of first-generation, low-income, students of color, stereotype threat theory provides insights into potential barriers to being academically successful. Stereotype threat theory asserts negative stereotypes of one's performance, based on his or her social group, can put individuals at risk of lower performance (Steele, 1997). Therefore, achievement problems of various social group identities may not be entirely based on skill deficiencies (Steele, 2010). For instance, the anxiety of stereotype threat, which has been physiological researched (Ben-Zeev, Fein, & Inzlicht, 2005), detracts mental capacity from learning academic content, which can decrease performance. To compound these challenges, Steele (2010) shared students who cared about school were influenced the most with stereotype threat, compared to those who were not motivated, where stereotype threat had less influence.

This theory has been well-documented and researched beginning with studying women's performance in math (Spencer, Steele, & Quinn, 1999), African Americans' performance on intelligence exams (Steele & Aronson, 1995), and intellectual achievement of low-income students (Croizet & Claire, 1998). It has been replicated with many other populations in various settings performing cognitive tasks (Walton & Spencer, 2009). Stereotype threat can be applied to first-generation, low-income, students of color with widely acknowledged stereotypes of a lack of preparation, less parental support, and social capital that could be detrimental to being successful in college.

Along with negatively stereotyped identities, university cues can influence stereotype threat, such as the number of people with similar identities, powerful people with similar identities, and the inclusiveness of institutions in embracing various identities. One cue can shape the interpretation of another. For instance, if a first-generation, low-income, student of color is unaware of other first-generation, low-income, students of color at a university that has strong messages of inclusiveness, the lack of students with similar identities is neutralized by valued diversity, which may positively influence first-generation, low-income, students of colors' sense of belonging (Steele, 2010). If institutions can promote narratives taking the threat away, more energy can be devoted to academic success.

Self-belief: Self-efficacy

Responding to the challenges of stereotype threat, self-belief may positively influence how students interact and experience the college environment. Self-belief is founded in Bandura's theory of self-efficacy and Dweck's theory of a growth mindset. Self-efficacy is a social cognitive theory based on "people's beliefs in one's capacity to organize and execute the course of action required to produce given attainments" (Bandura, 1977 p. 6). These beliefs influence decisions on how to proceed, and influences the individual amount of effort, perseverance, and resilience a person utilizes to achieve an accomplishment. Additionally, self-efficacy is an interdependent interaction of both an individual and societal influence through families, communities, and organizations. Consequently, unified efforts to promote self-efficacy can help promote optimistic courses of action to improve lives (Bandura, 1977).

The self-efficacy framework consists of four sources of efficacy, including mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. The influences from these sources of self-beliefs can be from one source, a combination of sources,

or within all sources (Bandura, 1977). First, to begin, mastery experiences are an individual's past successes or failures, which are the most influential in self-belief of one's capabilities. Successful experiences tend to enhance one's self-efficacy, and even a small performance success that influences an individual's outlook on his/her ability to succeed can enable a person to go beyond current performance levels to high levels of achievement (Bandura, 1977).

Second, vicarious experiences are comparing yourself to others. Seeing people modeling their successes can raise self-efficacy beliefs. Vicarious experiences are especially impactful, if people lack knowledge of their capabilities, such as starting college, or if they have had some failures in the past. Bandura (1977) suggests modeling is best accomplished when comparing with others, who are similar or slightly above the individual, such as sophomore college students working with first year students; and utilizing similar identities, such as first-generation, low-income, students of color to the individual(s) involved.

Third, verbal persuasion is significant others providing positive validation in the belief of an individual's capability to succeed. People who give feedback need to be authentic, skilled in the area, and have comparison information. As with vicarious experiences, verbal persuasion is most believable if it is given from people who are moderately beyond what the individual(s) can do at the time.

Fourth, the last source of self-efficacy is physiological and affective states, which influences people's perceptions of their capableness. For instance, a person can interpret stress as motivation to learn a new skill or as a hindrance to achieving a goal. Comprehensively, self-efficacy impacts actions taken in terms of the amount of effort, the perseverance in the face of obstacles and failures, and resilience to adversity. Although the various sources of self-efficacy provide opportunities to enhance an individual's personal belief in his/her capabilities; the

saliency of each of the self-efficacy sources vary, based on the individual, significant others, and the situation (Bandura, 1977).

Self-belief: Growth mindset

Expanding upon the theoretical framework of self-efficacy, that one can achieve his or her goals, is the growth mindset concept, which is a belief that one may improve through engagement with the learning process (Dweck, 2006). Within a growth mindset, everyone with differing levels of talents and aptitudes can change and grow to enhance his/her competencies and skills. Failures do not define the person, and success is about valuing challenge and being resilient in experiencing challenges. Therefore, mistakes can become a learning opportunity. This differs from a fixed mindset where one's qualities are perceived to be set in stone, success is about being more gifted than others, and effort is not a high value.

Both Bandura's and Dweck's theories of self-belief are included to provide a more comprehensive framework. The strength of Bandura's theoretical framework is the inclusive integration of the psychological, social cultural, and environmental aspects of a situation or experience, and the spectrum of varying levels of self-efficacy in a variety of sources (e.g., mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states) that can be developed. From my perspective, Dweck's growth mindset theory has limited emphasis on the social cultural aspects of a situation or experience and a somewhat restricted binary approach of either having a growth mindset or having a fixed mindset, providing a narrower perspective.

Additionally, a critique of Dweck's theory is the limited focus on effort without acknowledging the challenges of racism that may inhibit an individual's effort. Wood (2017) suggests more comprehensive messaging of both effort and ability, especially for Black men who

often have not received messages they have the ability to succeed. Although the growth mindset has been researched extensively with underrepresented populations and has demonstrated positive results on areas, such as academic achievement, this sole approach has limitations. Therefore, capturing the broader social context of self-efficacy, which includes mastery experiences or ability, along with including the growth mindset concept, strengthens the overall theoretical framework.

Individual and Societal Constructs of Stereotype Threat and Self-belief

When researching college first-generation, low-income, students' of color successes, it is important to incorporate these theories together within the broader context of individual and societal constructs, and the interdependent integration between them. Considering individual constructs, it is vital to appreciate the importance of underrepresented social group membership that may cause stereotype threats in negatively influencing performance, along with ways to promote students having successful experiences. These successes should be highlighted as mastery experiences, and include understanding physiological and affective individual states, like stress in Bandura's self-efficacy theory.

The theoretical social constructs that hopefully enhance self-belief and mitigate stereotype threat include reinforcing a growth mindset, creating vicarious experiences, such as exposing new students to upper-class students with similar identities to role model college success, and expressing verbal persuasions, such as university discourse to validate the belief of an individual's capability to succeed. Considering both individual and social constructs, and how they interconnect with each other creates broader lenses for researching first-generation, low-income, students' of color collegiate success in math completion.

Student Success Outcomes: Self-belief and Academic Advancement

Building upon the theoretical framework, it is important to consider the positive influence of self-belief on academic achievement that has been studied for all students, with some mixed results on the benefits of self-belief for underrepresented students. On the positive side, research has validated the influence of self-belief on grade performance (Gore, 2006; Loo & Choy, 2013), and graduation for first-generation, low-income, students of color (Lourdes, 2015).

Self-efficacy and Academic Achievement

Focusing on self-efficacy and academic achievement, self-efficacy was a strong predictor of academic performance, based on research conducted by Gore (2006), reporting higher grade point averages and first-to second-year retention rates of 1,100 first-year students with higher levels of self-efficacy. Similarly Vuong, Brown-Welty, and Tracz (2010) studied 1,291 students from five institutions and found self-reported GPA and persistence to be significantly related to self-efficacy. Koseoglu (2015) found effort regulation, self-efficacy, and seeking help explained 20% of the variance in grade point average. Ahmas, Hussain, and Azeem (2012) reported self-efficacy beliefs positively impacted academic achievement in particular disciplines, such as science or English. A different finding by Choi (2005) was self-concept, rather than self-efficacy, was a significant predictor of term grades. A meta-analysis was completed on the impact of self-belief and academic achievement, finding an overall small, positive impact with stronger impacts of self-belief within an academic discipline (Valentine, Dubois, & Cooper, 2004). This research suggests a slightly positive relationship between self-efficacy and academic achievement.

Looking specifically at generational status and ethnicity, research on first-generation, first year students found similar self-rating on math and verbal abilities compared to continuing

generation students, despite lower SAT scores (Atherton, 2014). Similarly, no differences between first-generation and continuing generation sophomore students were found with self-efficacy despite lower grade point averages and persistence levels of first-generation students (Vuong et al., 2010). Other research points to lower levels of self-efficacy of first-generation students (Ramos-Sanchez & Nichols, 2007). Additionally, Elliott (2014) found although first-generation students with increased levels of academic self-efficacy expressed greater academic adjustment than continuing generation students, they earned lower first year GPAs than continuing generation students.

For students of color, Torres and Solberg (2001) suggest academic self-efficacy serves as an important determinant in retention for Hispanic students. Additionally, after college first-generation, low-income, people of color college graduates identified self-efficacy promoted by faculty and peers as an influential factor of their college success (Lourdes, 2015). Consequently, the literature points both to the benefits and unfounded impact of self-efficacy on the academic achievement with first-generation, low-income, and students of color.

Growth Mindset and Academic Achievement

Exploring the relationship between growth mindset and student success outcomes, several studies demonstrated positive mindsets included brief exercises that target students' beliefs they have the potential to improve their intelligence, they belong, and are valued, improved academic achievement (Yeager & Dweck, 2012). For instance, Aronson, Fried, and Good (2002) found both African American and White college students, who attended a workshop on the growth mindset and tutored younger students about growth mindset, reported greater enjoyment of the academic process, higher levels of academic engagement, and significantly higher grade point averages than two control groups.

Research examining growth mindset and academic achievement defined by retention, Yeager and Walton (2011) focused on self-belief and persistence with ethnic, low socioeconomic status, and first-generation students. They found a growth mindset was a stronger predictor of persistence than social support or comfort in the university. Based on these studies, self-efficacy and a growth mindset seem to have a positive impact on academic achievement. The next section reports research that investigated self-efficacy and math achievement.

Student Success Outcomes: Self-belief and Math Achievement

More specifically beyond self-belief and academic achievement, is the connection of self-belief and math achievement. For example, research has shown self-belief impacts higher completion of challenging math courses (Yeager & Dweck, 2012), and completion of remedial math (Canfield, 2013).

Self-Efficacy and Math Achievement

Research on the relationship of self-efficacy and math achievement is evident internationally, both with students who have not performed well in math, along with engineering students with high levels of math performance. Studying 15 year old students in 33 countries using the same instrument discovered self-efficacy likely impacts math performance (Williams & Williams, 2010). Investigating students, who were repeating a developmental math course, Canfield (2013) identified high self-efficacy as the essence of their persistence, despite a low self-concept in mathematics. For engineering students, who usually excel in math, Loo & Choy (2013) found self-efficacy was correlated with mathematics achievement scores and cumulative grade point averages.

Specific aspects of self-efficacy have been found impactful, along with gender differences in math self-efficacy. Zeldin, Britner, and Pajares (2006) found mastery experiences

were important for men developing self-efficacy. For women, it was a positive validation in the belief of an individual's capability to succeed and seeing other female students do well in math. These findings may provide insights into self-efficacy and math achievement with first-generation, low-income, students of color.

Growth Mindset and Math Achievement

In addition to a relationship of self-efficacy and math achievement, research has found growth mindsets can positively predict math/science achievement over time for both middle school and university students (Dweck, 2008). Reinforcing a growth mindset, research has demonstrated greater course completion rates in challenging math courses (Yeager & Dweck, 2012). Even though research by Grant and Dweck (2003) was not focused on math achievement, it is worth noting, since it was in a science course, illustrating that a growth mindset predicted higher final grades in a college-level organic chemistry course.

Many studies have focused on the growth mindset as a mediating factor to stereotype threat of underrepresented populations in math performance. Dar-Nimrod and Heine (2006) studied math achievement and gender. They illustrated females with a growth mindset performed better than females with a fixed mindset on math assessments, similar to the Graduate Record Examination. Good, Rattan, and Dweck (2012) completed research on growth mindset and sense of belonging with females enrolled in calculus. They found sense of belonging significantly predicted the intent to pursue math and was related to math grades. Women, who experienced a growth mindset learning environment, had a higher sense of belonging and higher math grades, compared to women, who experienced an environment that enforced math ability as a fixed trait. Finally, a meta-analysis of several studies with students of color reported higher grade point averages among those with a growth mindset (Yeager & Walton, 2011).

Most of the research on self-belief did not identify first-generation, low-income student success or college students completing math courses. However, research on how self-belief may mitigate gender and ethnic differences may also be applicable to achievement gaps of first-generation, low-income students. To supplement the research summarized in this literature review, a methodology analysis is included to provide a summary of some of the research approaches in underrepresented student research.

Methodology Analysis of First-generation, Low-income College Student Research

Along with the comprehensive literature review on first-generation, low-income, students of color; a methodology analysis of 26 studies between 1996 and 2016 is summarized in this chapter and Appendix A to inform the research design of this study. This critical subset of studies was chosen that focused on an asset framework, investigated first-generation identities with nine studies intersecting students of color, and eight studies using low-income participants. Only three studies researched all three identities. Many of the studies implemented interventions to decrease graduation gaps, and considered both academic and psychosocial factors. There was also a focus on choosing studies commonly cited in research included in the literature review. Figure 1 illustrates the studies within a deficit or asset approach and the research methodology utilized.

Within this deficit to asset design, the deficit framework is illustrated by Terenzini et al. (1996), who focused on the differences of first-generation students compared to traditional peers and suggested differences impact potential learning problems. Using terminology suggesting first-generation students are “nontraditional” and their characteristics were a disadvantage to becoming successful in college emphasizes student deficits. The asset framework moves into an approach that either focuses on what makes first-generation students successful in college or

what universities can do to support their success. The asset approach is apparent in Stephens et al. (2014) research that provided an intervention to close the achievement gap of first-generation students.

Even though this subset of research is fairly distributed on the deficit and asset continuum, it should be noted these studies were chosen with a focus on asset-oriented studies, not representative of the amount of research on the deficits of first-generation, low-income, students of color. Another observation is most of the research within the deficit framework is older than the research within the asset approach, which may align with the more recent focus in higher education on student success.

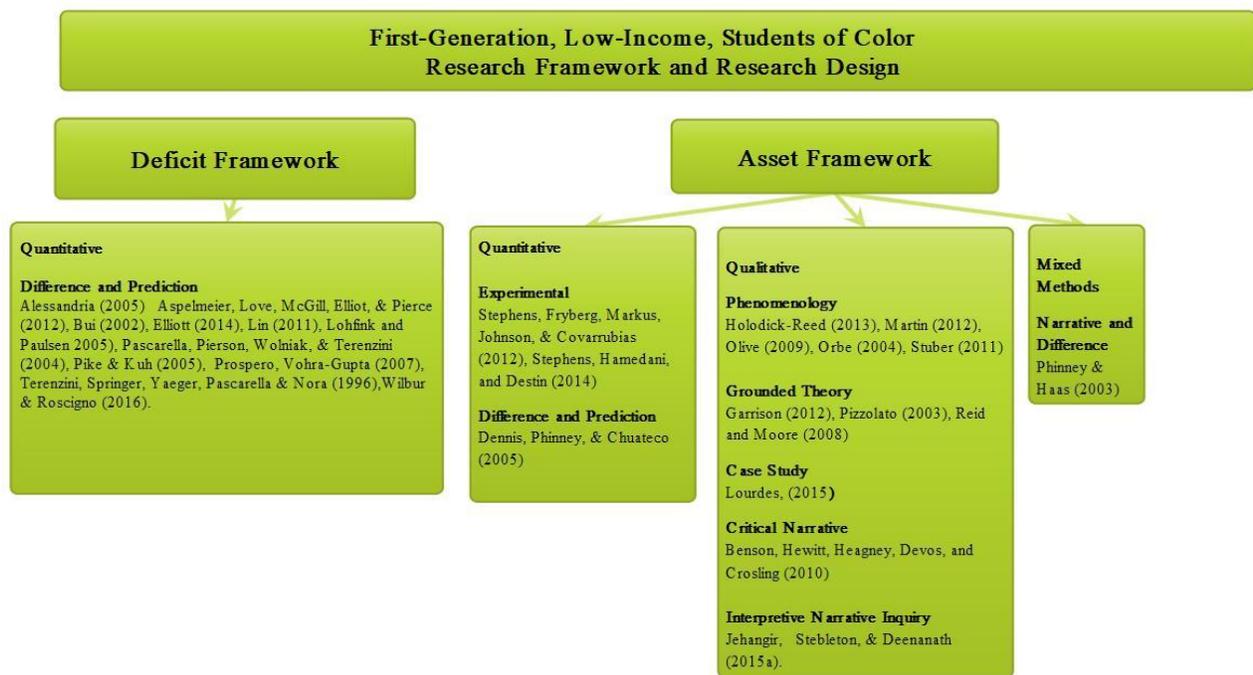


Figure 1. First-Generation, Low-Income, Students of Color Research Framework and Research Design

Recommendations for future research resulting from the methodology analysis include longitudinal quantitative studies with large samples from multiple institutions, since most of the longitudinal studies larger in scope were conducted more than a decade ago. Regarding the sample selection with the qualitative studies, many utilized first-generation students from collegiate success programs (Lourdes, 2015; Olive, 2009; Pizzolato, 2003; Stuber, 2011) which may have implications on the research findings. Consequently, this study will research students not involved exclusively in collegiate success programs to broaden the understanding of these students. Finally, more research is needed that focuses on various identities rather than focusing on one or two identities that limit understanding student experiences.

Summary

After reviewing the research on college experiences of first-generation, low-income, students of color, the focus on the disparities of these students and the achievement gaps are readily apparent, but not well understood. The research agenda needs to continue to move away from focusing on the deficits of this underserved population as a disadvantage to being successful in college, which reinforces marginalization without possible solutions to increase graduation outcomes (Bensimon, 2005). A new paradigm centered on learning more about first-generation, low-income, students of color within a talent development approach will encourage students to thrive and fully engage in their collegiate experience. This philosophical framework provides the opportunity for higher education institutions to strategically provide an environment that empowers thriving students from varying backgrounds (Schreiner et al., 2012).

Moving even further beyond developing the talent of first-generation, low-income, students of color is for higher education institutions to confront institutional structures and systems that fuel inequalities (Castro, 2014). The paradigm shift to a student asset orientation

paired with research framed in developing solutions of how institutions can positively influence underrepresented students' success may lead to more sustainable possibilities in closing the graduation gaps.

CHAPTER 3: METHODOLOGY

The purpose of this study is to explore first-generation, low-income, students' of color experiences with math placement and pre-calculus/calculus math courses, and how university factors influence the self-belief of these students to be successful in math. This research is completed within the perspective of promoting the strengths and assets of students to encourage student success, with a theoretical framework of stereotype threat (Steele, 1997), which challenges college success, and self-belief (Bandura, 1977; Dweck, 2006), which can potentially mediate challenges and promote academic success.

One large research university was utilized to explore first-generation, low-income, students' of color experiences in pre-calculus/calculus courses, as part of the Progress Through Calculus National Science Foundation research project. This chapter provides a broad overview of the Project Through Calculus research that studied ways to enhance student calculus completion rates, providing a context for the university case study. More specific information includes philosophical assumptions, methodology, research approach, participants, data collection, data analysis, trustworthiness criteria, along with the delimitations and limitations of this study.

Progress Through Calculus Research Study Overview

This dissertation study focuses on a slice of the broader Progress Through Calculus study sponsored by the Mathematical Association of America and funded by the National Science Foundation (NSF) to research calculus progression. This research project built on the insights from another NSF Grant entitled Characteristics of Successful Programs in College Calculus (CSPCC) that identified department-level factors, which influenced student success from pre-calculus to calculus. The subsequent research focused on student success in the sequence from

pre-calculus to calculus II (P2C2) with universities that offer a graduate degree in Mathematics, because these institutions produce the bulk of STEM graduates. The research questions below provide context for this study, acknowledging that these questions are beyond the scope of this research.

Research Questions

1. What are the programs and structures of the P2C2 sequence as currently implemented?
 - a. What programs and structures are currently in place and how common are they?
 - b. What changes to these programs and structures are implemented in Mathematics departments, either in pilot programs or as large-scale initiatives?
 - c. What is the fine-grain structure of these programs and structures in practice?
2. How do characteristics of P2C2 programs relate to student success?
 - a. How do Mathematics departments characterize themselves in terms of implementation of the practices identified in CSPCC as characteristic of successful programs?
 - b. What is the relationship between various structural, curricular, and pedagogical decisions (including differing levels of implementation of the practices identified in CSPCC) on student success in P2C2?

Case Study Selection

The Progress Through Calculus research project began with a survey sent to all 331 United States institutions granting mathematic graduate degrees for which 67% (233) responded to a survey about their undergraduate math program. Initial analysis of institutional approaches and program outcomes were utilized, based on institutional survey responses and National

Education Statistics data to identify twelve institutions for study. Institutional approaches included math placement, course structure, active learning, student support, instructor coordination, graduate teaching assistant training, integration with math and other STEM disciplines, and local data analysis. Program outcomes included persistence in math, percentages of D and F final grades, withdrawal rates, math content knowledge, performance in upper division math courses, and STEM graduation rates, including women and students of color.

Final institutional selections were based on interesting, innovative approaches used with positive outcomes, positive outcomes without as many apparent innovative approaches, and institutions that had demonstrated investment in participating in this study. The twelve case study institutions were a mixture of master and doctoral programs, private and public, and large and small institutions. This process followed the recommendations of (Fryvbjerg, 2011) to use critical cases most likely or least likely to allow logical deductions, and maximum variation cases with diversity in size and type of organization.

Most importantly within the overall selection framework, there was a focus to identify institutions that have graduated larger numbers of underrepresented students defined by gender and ethnicity in STEM degrees than expected, based on national statistics. As part of this final selection process, the percentage the Pell Eligible students were shared, based on National Education Statistics data. However, first-generation student information was not utilized, since this information was not collected as part of the national database.

Data Collection

After determining the twelve institutions to participate in the case studies, three pilot case studies were initiated during Spring 2017. Five researchers, including the author, implemented

one of the pilot studies at a selected higher education institution, based on geography, convenience, and access to refine data collection content and procedures.

Prior to the fall 2017 site visit at the case study institutions, IRB approval was gained from each institution. The respective institution's contact, typically a coordinator in the math department, conveyed a general understanding of the institution, assisted in the process of distributing surveys, and helped identify faculty and staff interview contacts. On-line surveys were given to pre-calculus and calculus instructors about their teaching approach, as well as students enrolled in calculus courses to gain information about their experiences in math. The first site visit consisted of interviews with faculty, graduate teaching assistants, administrators, and student support staff; as well as classroom observations. The second visit occurred spring 2018, which included follow up interviews and focus groups.

Research University Case Study

As a selected portion of the Progress Through Calculus Grant, this study focused on one of the institutions that participated in the grant research project using the pseudonym, Research University. The student experience was central to this case study's purpose.

Philosophical Assumptions

The philosophical approach of this research is within a constructivist paradigm, which focuses on a subjective world with multiple realities, individuals constructing their own understanding of reality, researchers and participants interacting collaboratively in a democratic dialogue, and understanding the complexity and patterns of individual experiences to inform and hopefully improve practice (Guba, Lincoln, & Lynham, 2011). More specifically, this study focuses on understanding the reality of first-generation, low-income, students of color, based on their perspectives and experiences of completing math in college within an asset rather than a

deficit framework. In other words, this research is centered on the talents rather than the insufficiencies of these students. The collaborative experience of having the expertise of the lived experiences of these students along with a researcher knowledgeable in higher education student success strategies created a more comprehensive understanding of these experiences.

In using the constructivist paradigm to inform and improve practice, first-generation, low-income, students of color participating in this research became more empowered by sharing their stories. This research is also based on the power of positive psychology, the study of conditions that influence the optimal functioning of people (Gable & Haidt, 2005). This philosophical framework offers great possibilities for institutions to take action in creating an environment that promotes self-belief in developing the talent of first-generation, low-income, students of color to hopefully become successful in math.

Methodology

The methodology in this study is qualitative research, which focuses on observing and interpreting phenomena through various representations, including life stories and introspection to understand meaning making. Some characteristics of qualitative research are connecting the parts to the whole, capturing the individual's point of view, examining the constraints of everyday life, and securing rich descriptions (Denzin & Lincoln, 2011). This methodology is impactful, since much of the research on self-belief is quantitative (Dweck, 2008; Gore, 2006; Loo & Choy, 2013; Pajares, 1996). Consequently qualitative research will add depth to the current literature.

Research Approach

A case study approach was used as the means to understand a complex social unit problem holistically (Merriam, 1988), which, for this research, was student experiences in math,

and to study “how” and “why” questions (Yin, 2003) that informed these experiences.

Qualitative research aligns with a case study because it provides rich data to answer the how and why questions. Within a qualitative case study approach, this study utilized multiple sources (Merriam, 1988), gathered in-depth information over time (Fryvbjerg, 2011), focused on the contextual environment (Fryvbjerg, 2011), and gained multiple perspectives with a progressive focus reconsidering issues throughout the research process (Stake, 1995).

Multiple data sources for this study included student interviews and student focus groups, and institution contextual information. In-depth information was gathered with three individual interviews of eight first-generation, low-income, students of color, and two focus groups with these same students over a six-month period. Contextual information about the institution was collected through websites, information from the local coordinator, faculty and staff interviews, and classroom and support program observations. Finally, multiple perspectives were gathered from students in both an individual and focus group setting, and from faculty and staff in interviews and observations.

Research Questions

The specific research questions for the Research University case study include:

1. How do college first-generation, low-income, students of color experience math placement and pre-calculus/calculus mathematics courses?
2. What university factors influence the self-belief of college first-generation, low-income, students of color success in math?

Case Study Selection

As mentioned earlier within the overall selection framework of the Progress Through Calculus research, there was a focus to identify institutions that have graduated larger numbers

of underrepresented students defined by gender and ethnicity in STEM degrees than expected, based on national statistics. Within the twelve case study institutions, four were specifically identified that have made progress in this area.

Further investigation of these four institutions focused on the numbers of first-generation, Pell Grant eligible, students of color, and approaches to math placement. Three institutions were not selected for the following reasons. One institution was private and highly selective, even though they graduated high numbers of women and African American students in STEM areas. However, the numbers of first-generation, low-income, students of color were drastically lower than the national average, which was undesirable, since the focus of this study is to increase access for these students.

Another institution was moderately selective, percentages of first-generation students were unavailable, and there were no innovative approaches with math placement mentioned in the survey. This information was coupled with lower graduation rates than expected of Hispanic students in STEM degrees as determined from the Progress Through Calculus survey information. The last institution, although less selective in the admission process, had lower percentages of first-generation students (16.2% reported on the institution's website) than the national average, which could prove limiting to obtaining a purposeful research sample.

The selected institution is a large public research institution with an enrollment of 54,000 students. There are 50% first-generation students reported on the institution's website, 41% Pell Grant Eligible students, and 81% students of color (National Center for Education Statistics, n.d.), which are well above national averages. Additionally, this institution has both high outcomes with the number and diversity of STEM degree graduates, particularly with Latino students; and innovative approaches include active learning, student support services, and a math

department connection with other STEM degrees. The large numbers of first-generation, low-income, students of color, innovative approaches with student support, and success with underserved student graduation rates comprehensively merited selecting this institution.

Participants

Upon receiving IRB approval, I worked with institutional research staff at the Research University to request all first-generation students, defined as those students whose parents did not have a college degree, Pell Grant eligible, who may or may not have been Pell Grant recipients, enrolled in either pre-calculus algebra, pre-calculus with trig, or calculus I during fall semester 2017. Of the 2,930 students enrolled in these math courses, 610 students were first-generation (21%), 1,369 students were Pell Grant eligible (47%), and 468 (16%) students were first-generation, Pell Grant eligible students.

An email was sent to the 468 first-generation, Pell Grant eligible students requesting their participation and offering a \$50 Amazon gift card for their involvement. Twenty students responded to the email. Of these 20, eight students were selected to have equal distribution of students taking pre-calculus and calculus. Additionally, names were utilized to gain a gender balance and selection of a variety of majors. One of these eight students decided not to participate, due to personal reasons. Consequently, another student was selected from 20 students who matched the criteria of the student who declined participation. The new participant shared he was no longer interested in participating. Hence, six additional students on the waitlist were notified for selection. The first student who responded was selected. In addition to being first-generation, low-income students, all student participants were students of color and majoring in STEM.

This was a purposeful sample, based on the assumption the sample is selected from those

who can provide the most insight to be gained (Merriam, 1988). Follow-up email messages and phone calls by this researcher were used to solidify their participation and schedule interview times.

Data Collection

The primary data collection for this study was three student interviews with eight first-generation, low-income, students of color, and a student focus group comprised with six of these eight students. One student, who did not participate in the focus group, had to work during the scheduled time. The other student moved when she transferred to another school. The first interview was conducted as part of the three-day site visit during October 2017. Information from the local coordinator and websites was collected prior to and during the site visit. It was utilized to enhance the student interview questions. Throughout the site visit, field notes were taken to document and make observations on the data collected. After the fall semester was completed, follow-up student interviews were conducted via the web with these same eight students. The final student interviews were completed via web during early March and the focus groups took place during the second site visit in late March 2018. The data collection process is outlined in Table 1.

Types of Data Collection

There were several types of data collection with a focus on individual interviews, a focus group, and gathering institutional context to provide multiple perspectives. The consent form for the interviews and focus group is illustrated in Appendix B.

Interviews. With reference to the interview process, both an in-depth phenomenological and a semi-structured approach were utilized. Well-constructed interview questions were

developed and refined after the pilot study and after each set of interviews, providing interview protocols to eliminate bias (Yin, 2003). The interview questions are provided in Appendix C.

Table 1. Data Collection Process

Data Method	Data Means	Data Collection Timeline
Institution context	Website review, local coordinator interview	9/1/2017
Student Interview One	Audio Recorded	10/10-12/2017
Institutional Context	Staff/Faculty Interviews, Audio Recorded and Notes Classroom Observation Notes	10/10-12/2017
Student Interview Two	Web Recorded	12/2017-1/2018
Student Interview Three	Web Recorded	2/2018
Student Focus Group	Audio Recorded	3/2018
Institutional Context	Staff/Faculty Interviews, Audio Recorded and Notes Classroom Observation Notes	3/2018

The comprehensive process of three separate interviews focused on life experiences to make meaning of these experiences. The first interview was conducted to build rapport and gain an understanding of the student’s background and self-belief about math and college success that informed the present situation. The second interview was focused on students’ math experiences during fall semester through stories and concrete examples. The final interview included reflection of their fall semester experiences along with current math experiences in the spring semester, to illustrate the intellectual and emotional connections to their experiences. To accomplish this in-depth approach, each interview was 35-60 minutes. Validity was gained from opportunities for clarification, further probing, and summarizing during the interview process (Merriam, 1988); placing the student’s comments in context, conducting several interviews over

a period of six months, and having the student make meaning of his or her experiences (Seidman, 2006).

High quality interviewing techniques were utilized, such as listening, exploring, and using open-ended questions, with a focus on developing a collaborative relationship between the researcher and the interviewees. It was also imperative to be sensitive to the varying identities of the researcher and interviewee, including ethnicity/race, gender, and class, and to value equity as part of the interview process. Conducting three student interviews provided an opportunity to demonstrate respect and interest in the various identities of each student, as well as build trust and value student responses during the interview process (Seidman, 2006).

Focus groups. Beyond interviewing, the strength of focus groups is the synergistic interaction of how people process issues that occur in everyday life together, producing norms seldom produced in interviews and observations. The groups are multifunctional in understanding collective engagement, raising the consciousness of group members, and providing inquiry with complex, nuanced, and rich understanding (Kamberelis & Dimitriadis, 2011). The power of collecting data from a group of individuals can provide a safe place with comfort of being together to express thoughts. Focus groups are recommended for understanding people with gaps with others, complex behaviors, and diversity issues (Morgan & Krueger, 1998). Specifically, focus groups can be an impactful venue for homogeneous groups, such as women of color focusing on feminist issues (Madriz, 2000) and indigenous people discussing learning in math (Cooper, Baturo, Duus, & Moore, 2008).

Focus groups promote a democratic process between the participants and the facilitator, require the researcher to be vulnerable in responding to multiple and contradictory perspectives, and provide an opportunity for participants to reflect and be interpretive with each other. The

challenges are to operate in good faith, not reaching conclusions too quickly, and to uphold the anonymity of the participants (Kamberelis & Dimitriadis, 2011). Focus group protocol recommended by Krueger (1998) to moderate the focus group with guided discussions for multiple interactions with all participants, rather than two-way conversations between the researcher and participant, was incorporated in the focus group process protocols.

As with the interview questions, focus group questions were developed, pilot tested before the study, and refined (Appendix D). Utilizing the same students interviewed to participate in the focus group was useful, since a rapport had already been developed between the researcher and students during the interviews. Additionally, having a homogeneous focus group of first-generation, low-income, students of color created a safe place to share experiences, especially those who have a high saliency with these identities. Student participants were able to learn from other students in the group, when hearing their stories, which inspired more in-depth reflections and additional perspectives about their own experiences, as well as new insights about their future collegiate experiences.

Institution context data collection. To gain an understanding of the institutional context of math at the Research University, information was gathered from the local coordinator in the math department, website content, faculty/staff interviews, and support center and classroom observations. During the research process, this context was developed within a focus on student messaging about self-belief and student success within an asset or deficit framework. The local coordinator assisted this researcher to find the most meaningful institutional information that was authentic and relevant to this study (Merriam, 1988). Student discourse about math placement and math requirements were analyzed via website information geared toward incoming students, and information about math experiences and student support services was collected from various

interviews with the Math Lab Coordinator, math faculty, Math Department Head, learning assistants, and classroom observations.

These patterns and themes of the institution context information were incorporated into interview and focus group questions to learn how students responded to the institutional context. Throughout the data collection process of this case study, there was an attempt to ask good questions, actively listen, be adaptive and flexible, have a firm grasp of the issues, and not be biased by preconceived notions (Yin, 2003).

Research Questions, Theoretical Framework, and Data Collection

Comprehensively, the research questions, theoretical framework, and data collection are summarized in Table 2. This summary illustrates the connection between each research question, theoretical focus, and type of data collection.

Table 2. Research Questions, Theoretical Framework, and Data Collection

Research Question	Theoretical Framework	Data Sources
1. How do college first-generation, low-income, students of color experience math placement and pre-calculus/calculus mathematics courses?	In learning about math experiences, it is vital to understand the importance of underrepresented social group membership that may cause stereotype threat in negatively influencing performance, as well as the potential of self-belief that can mitigate stereotype threat. This framework assists in the analysis of how students' self-beliefs influenced their experiences with college math.	Student Interviews, Student Focus Group
2. What university factors influence the self-belief of college first-generation, low-income, students of color for success in math?	Stereotype Threat and Self-belief will be used as a framework to look at the influences of university factors on students' math experiences. Factors that can influence stereotype threat include the number of people with similar identities, powerful people with similar identities, and the inclusiveness of the institution to embrace various identities. Additionally, university factors can influence self-belief to reinforce a growth mindset, create vicarious experiences to role model college success, and express verbal persuasions to validate the belief of an individual's capability to succeed.	Environmental Context, Student Interviews, Student Focus Groups

Data Analysis

Holistic data analysis was accomplished with an inductive process to identify relevant emerging themes (Yin, 2003), making sense of the data collection (Miles, Huberman, & Saldana, 1994). To begin, the interviews and focus groups were transcribed and included reflective researcher notes compiled between interviews, and before and after the focus groups. This researcher analyzed the interview and focus group transcriptions with MaxQDA, a qualitative coding software program. To begin, a case level description of each participant was done to capture individual stories and experiences. Coding each interview and focus group created a coding summary of categories, which began with a sequential timeline or event-listing matrix of math placement, first semester math courses, and second semester math courses. Each math course experiences were coded separately including Pre-Calculus College Algebra, Pre-Calculus College Algebra and Trigonometry, Trigonometry, Calculus I, and Calculus II. Some of the sub codes for each math class included challenges and responses to challenges, success strategies, reaction to course format, and how student identities impacted course experiences. Additionally other general codes included family influences, institutional factors that promoted success, self-belief, and perceptions about math.

In the second-cycle coding process, the researcher conducted a conceptual analysis with all the coded sections in each category, to explore the themes and patterns of the entire experience (Miles et al., 1994). At that point, it was determined that the experiences in varying math courses had similar patterns so all math courses were combined together in overarching themes. The code categories were transformed into a smaller number of themes, recognizing that explanation building or a theme generating process was utilized throughout the analysis (Yin,

2003). After the themes were developed, a conceptual model was created to show the connections between the themes.

Throughout the data analysis process, high quality data verification was implemented, including attending to all the data and using this researcher's expert knowledge (Yin, 2003). For instance, qualitative themes from the student interviews were compared with the institutional context data to be inclusive of all the data collected. This researcher's expertise for creating generalizations was balanced with including naturalistic generalizations or description of experiences (Stake, 1995). Collectively the data analysis of breaking apart and piecing together data themes illuminated further understanding of the math experiences of first-generation, low-income, students of color (Merriam, 1988).

Trustworthiness

The core principles of trustworthiness for this study were triangulation of data sources, incorporation of various evaluators with different theoretical perspectives, utilization of a case study database, and continual maintenance of a chain of evidence (Yin, 2003). Triangulation of multiple sources including interviews, focus groups, and institutional context which enhanced the richness of the study. Additionally, working together with other researchers with mathematics backgrounds provided an additional perspective to my higher education background, which broadened the collective lens of this research.

Regarding the case study database, all the data collected from the Progress Through Calculus Grant resided in one secure location that could only be accessed by the research team. Supplementing the database, field notes were taken by all researchers and compared to each other's documents for a collective chain of evidence. Finally, as part of the data analysis, rich

thick descriptions, peer review of the site visits with other research team members, and research journaling all contributed to the validity of this study.

Research Ethics

To maintain the upmost integrity throughout the study, this researcher acknowledged the importance of confidentiality throughout the research process. The institution studied was never identified to protect the organization's anonymity. Even though institutional and math department discourse was used as part of this research, this information was used to inform student interview and focus group questions. Therefore, the institution's anonymity was upheld. Additionally, all interviewees signed a consent form. This researcher discussed the confidentiality in the focus group both for the participants to not share the identity of other participants or share information that individual participants discussed during the focus group. The researcher's obligations not to identify any of the interviewee's individual names as part of the study was upheld by using pseudo names.

Delimitations

This study is based on one large research public institution within a timeframe of the 2017-2018 academic year. Participants were first, second, and third year first-generation, Pell Grant eligible, students of color, in STEM who completed two semesters of pre-calculus/calculus courses. First-generation was defined as students with either parent not possessing a bachelor's degree. Low-income status was defined by eligibility for the Pell Grant. Race/ethnicity was self-reported. Additionally, this research focused on student experiences with math.

Limitations

As with any qualitative research, study findings cannot be generalized to the entire first-generation, low-income, students of color population or all higher education institutions.

Utilizing rich data from students over time, as well as gaining contextual information from the institution, were mechanisms to understand math experiences, acknowledging this research still provided limited exposure to the full experience of first-generation, low-income, students of color and self-belief in math success on one campus.

Additionally, although there are limits to focusing on self-reported data rather than direct observation, this study captured the realities of first-generation, low-income, students of color. Hence, this approach was appropriate. Finally, focusing on first-generation, low-income, and ethnicity represent only three student identities. This does not account for all of the other identities of these students, as well as the intersectionality between the students' identities. Including first-generation, low-income, and race/ethnicity as the focal point was achieved to keep the research within a reasonable scope, but the limits of focusing on only three identities should be noted.

Summary

In summary, the purpose of this study was to explore first-generation, low-income, students of color experiences with math placement and pre-calculus/calculus math courses. This case study with one higher education institution was implemented within a constructivist paradigm, using qualitative research through student interviews and student focus groups. Specific data collection and data analysis procedures were outlined.

CHAPTER 4: INSTITUTION CONTEXT AND STUDENT STORIES

Chapter 4 illustrates the case study's milieu beginning with institutional context and illustrating each student's story. The institutional context was captured from the local coordinator in the math department, website content, faculty/staff interviews, and support center and classroom observations during two site visits to this campus. Additionally, each student's rich story is captured to provide in-depth insights of his/her unique background and experiences.

Institutional Context

The Research University is a large, public, research university with an enrollment of approximately 54,000 students. The majority of students are students of color, with half first-generation, and slightly less than half as Pell Grant eligible. Additionally, this institution is a Hispanic serving university, which is determined by enrolling 25% or more Hispanic students. Comprehensively these Hispanic serving institutions provide greater access to higher education, have diverse student enrollments, are more affordable than other similar institutions, and graduate a high percentage of all Latinos earning degrees (Santiago, 2006).

More specifically, Research University had successful outcomes regarding the number and ethnic diversity of STEM degree graduates. For instance, 67% of bachelor graduates were Hispanic, and 64% of Hispanic graduates had STEM degrees. These fairly similar proportional percentages were higher than other Hispanic serving institutions that were included in the Progress Through Calculus research project. During the site visits, it was invigorating to visit the Student Union and see students with various ethnicities interacting together in dance, playing chess, and just enjoying each other's company.

A high priority in supporting underrepresented students, especially Hispanic students, was

evident on this campus. This university has a much larger percentage of Hispanic faculty than the national average, has been acknowledged for inclusive campus-wide communication, and has a strong TRIO program. Examples of support for first-generation students are state funds to match private donations for first-generation student scholarship monies, programs supplementing TRIO specifically designed to support first-generation students, and recommended books for faculty to read to better understand this student identity.

There are many messages displayed around campus about the importance of student success for all students; including graduating in four years, which was also articulated in math faculty and department head interviews. Although university wide support for student success was authentic, there was extreme pressure from the state that ranks higher education institutions, with financial implications. Institutions with lower rankings receive less state funding, and this institution is on the borderline of receiving less funding if there is no improvement in four year graduation rates.

Focusing on mathematics, the department is large (33 faculty and 45 instructors) and almost all faculty teach in the pre-calculus/calculus sequence, with no graduate students teaching these courses. Considering instruction roles, there is a combination of teaching instructors within a structure of promotion, along with tenured faculty. The Math Department Chair was proud of the number of recent instructor hires that are women and Hispanic.

The observed small class size (approximately 30-40 students) in this study was impressive, especially at this large institution. Based on classroom observations, there were drastic extremes of traditional lecture approaches focused solely on teaching math, to inclusive classroom communities with active learning, focused both on math content and student success. Two of instructors that I interviewed were alumni of the institution and impressively dedicated to student

success especially of underrepresented populations, and proud of their efforts in educating students in STEM.

Over the past several years there has been a dramatic improvement in College Algebra pass rates (30-70%), with the implementation of a high-tech, high-touch, Math Mastery initiative, including study requirements in the Math Lab with interactive student learning assistants. This is a notable accomplishment, especially since it was conveyed that there were issues with the education at the public high schools in this area. On the other hand, the pass rate for Calculus I is slightly above 50% and there is great institutional pressure to increase these rates.

The STEM Institute at the university focuses on supporting instructional change among STEM faculty and has made progress notably in Chemistry but also in math. Faculty teaching Pre-calculus and Calculus I have been awarded HHMI grants to support instructional change; others have attended workshops on active learning techniques. The STEM Institute also oversees coordination of learning assistants to supplement instruction; which includes an extensive selection process, a semester course for the learning assistants, and on-going training during the classroom experience. Courses that integrate learning assistants report 10-29% higher pass rates.

Although there is innovation happening both in the Math Department and in the STEM Institute, there was some tension between upholding the expertise of the Math Department to teach math courses, and the STEM Institute's desire to institute new innovative teaching approaches to improve math completion rates. The Research University provided an interesting site to research, since it serves such a diverse population, has made improvements in math success, and has impressive graduation outcomes for traditionally underrepresented STEM students.

Student Profiles

The selected group of first-generation, low-income, students of color ranged in years in college, had various STEM majors, and took both pre-calculus and calculus courses. The majority of the students were Hispanic (six Hispanic, one Asian American, and one multiracial). In regard to class standing, the students ranged from first year (five students), second year (two students), and third year (one student). Four students were born in another country and many of the student's parents immigrated to the United States. Four students were female, and four students were male. Seven of the students lived at home and one student lived in the residence hall for the first semester, and then moved home for the second semester.

These students had various math pathways, with one student beginning his first year with remedial math, another student starting in math for social sciences and then switching to the pre-calculus track, and another student beginning Calculus I in his first semester. For fall semester 2017, the students were enrolled in Pre-Calculus Algebra (two students), Pre-Calculus with Trigonometry (two students), and Calculus I (four students). During spring semester 2018, students were enrolled in Trigonometry (one student), Calculus I (five students), and Calculus II (two students). All students were majoring in STEM areas, with three students majoring in biology, and one student studying in each of the following majors; environmental studies (changed to philosophy), biochemistry, mechanical engineering, chemistry, and exploring engineering. A summary of the student demographics is outlined in Table 3.

Student Stories

Each of these students has a unique, interesting path attending and navigating college, with a focus on their experiences with math placement and math courses. These paths were

woven with successes and failures, and variations and changes in their sense of belief in being successful in math, through these experiences.

Table 3. Student Demographics

Name	Year in School	Ethnicity	Major/Minor	Math Placement	FA 2017 Math	SP 2018 Math
Lucas	First Year	Asian American	Biology	Pre-calculus Algebra	Pre-Calculus Algebra	Trigonometry
Sofia	First Year	Hispanic	Biology	Placed into calculus, started the class and was behind (missed summer prep of calculus in Cubic) transferred to pre-calc	Pre-Cal Alg and Trig	Calculus I
Lucia	First Year	Hispanic	Biochemistry	Placed into calculus- wanted to take it slowly	Pre-Cal Alg and Trig	Calculus I
Ben	First Year	Latino	Mechanical Engineering	Calculus I	Calculus I	Calculus I
Martin	Sophomore	Hispanic	Computer Engineering	Intermediate Algebra	Pre-Calculus Algebra	Calculus I
Diego	Sophomore	Multiracial- Hispanic, Caucasian	Chemistry Minor in Biology with teaching certificate	Pre-calc with algebra. 1 point from Pre-calc and Trig so he took Pre-Calc Trig in the summer	Calculus I	Calculus II
Victoria	Sophomore	Hispanic	Biology	College algebra	Calculus I	Calculus I

Isabella	Junior	Hispanic	Started in Environmental Sciences, changed to Philosophy. Wants to get a second bachelor's in Engineering	Placed in Pre-Calculus, decided to start at a lower level to ensure she understood the concepts	Calculus I	Calculus II
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Lucas

Lucas identified as an older brother of four, first-generation, part-time worker, student, and Asian American. He described himself as kind, charismatic, sarcastic, and interested in fashion. He struck me as gracious, authentic, and dedicated. His parents are from Vietnam, and he said his mother was most influential to his college experience by driving him to do better and work harder. He has a sixteen-year-old brother, a fourteen-year-old brother, and a five-year-old sister, whom he mentioned often since he had a major role in taking care of and teaching his younger siblings.

Like growing up, I didn't have really a lot of resources. Like my parents were always working really late and stuff. So, I would have to do everything on my own and being like an older brother this taught me not only, like I have to teach myself, but also I have to learn the material and teach it to my younger siblings.

All the students had a great appreciation for being in college, but Lucas's immense heartfelt gratitude especially stood out, sharing that in Vietnam one was considered successful if a high school graduate. He shared how lucky he was to be in college when his cousin of a similar age had the talent and desire to attend college, but did not have the opportunity. I thought it was insightful that he described college as an innovative learning experience rather than just focusing on career opportunities, and an experience that he looked forward to sharing with his

children. He also recognized the applicability of math (e.g. construction, finances), which was not a theme with the other students.

He loved the cultural diversity, the energy at the Student Union, and all the resources the institution made available to support students. Although he enjoyed being a college student, he did not value having a sense of belonging or being involved at the Research University. This may have been partially impacted by working twenty hours a week in a shoe store, family responsibilities, and being new to the college experience. However, other students in this study with similar commitments were more involved. I could see him build stronger connections in the future.

What I appreciated about Lucas is learning about how much he was evolving as a college student. It was eye opening for him to discover how practicing and making an effort really made a difference in successful performance. I do not think he put a lot of effort into high school, but he was determined to step up in college, starting with getting A's in two courses in summer school when most of his friends did not start college until fall semester. During the school year, Lucas became a more interdependent learner, by becoming more confident in asking questions in class and appreciating the value of working with other students to enhance his learning.

Lucas was certain, as a first-year student majoring in biology, he wants to be a trauma surgeon. He placed into pre-calculus algebra without any preparation because he wanted an accurate reflection of his math ability. Lucas did not seem bothered by having to take all of the pre-calculus courses, even though he took these courses in high school. He had a lot of self-belief that he could do well in math and seemed to have a good sense of what it took for him to be successful in math courses. During his first year, he completed and did well in pre-calculus algebra and trigonometry courses.

Sofia

Sofia was impressively a determined individual who welcomed challenge, could excel in any environment, and gained a strong appreciation of the power of learning within a community during college. She took great pride in being first-generation, navigating the path to college on her own, and described herself as individualistic. When talking about her first-generation identity Sofia shared:

I think it (being first-generation) impacted everything. My standards have always been set so high just because you know normally if you are first-generation student you are striving to be the best you can be. So, like when you get into a school you can say I did absolutely everything that I could to get in here. Yeah, I think everything was affected by being a first-generation student. Because I feel like I wouldn't have had that drive.

That drive definitely set me up for the path that I'm on.

Her ambition and focus were evident as a pre-med student majoring in biology, who has known for seven years that she wants to be a cardio surgeon. Sofia was also adamant that she did not want to be defined by the stereotypes of being female or Hispanic.

When people see me and they see I'm Hispanic, there's just a lot of misconceptions with the fact that there's just going to be a limitation on what I can do as an individual. Just because it's assumed that my parents didn't go to college and that I maybe don't speak English as well, or that I have trouble understanding just the material. In general, and I think that that's one of the misconceptions that is one of the bigger ones nowadays, just because of how things are going right now.

Being proud to be a strong weight lifter was one way she demonstrated her distinctiveness defying societal norms.

Sofia was constantly negotiating the incongruence between her independence and family bonds, wanting to attend an out-of-state college, but deciding to stay in-state; living away from home the first semester, which was unique with the students in this study, and then transferring to another school second semester so she could live with her family. The conciliation between being individualistic and part of a community was also evident in her course experiences.

Her greatest accomplishment in college, thus far, was being part of an intensive STEM program. This program was a small cohort of students majoring in biology who took courses together, integrated math and biology disciplines through journaling and professional development activities, and gained support for success. Being part of this learning community was a transition for her. When asked who was the most influential in college, Sofia shared about her peers in the STEM program.

That is hard, because I don't talk to many people. I definitely say my peers. When I was in high school, I was a loner type person. So, I always studied on my own and succeeded on my own. But here, I had to become a different type of person. A person who had to learn to interact with others. So, I would say my peers because they are all very goal-oriented. We have study groups. Even after the study groups we have with our higher ups, we meet again and go over the materials.

Sofia talked about her experiences spring semester at another institution where she was no longer part of the STEM program.

That's one of the things I miss from [the Research University] is that I had a really close-knit group. Here, it's just not that way, but it doesn't bother me. It's fine.

The take away message for me from Sofia's experiences was the importance of structured learning communities, since I do not think she would have come to appreciate the community

support unless she had participated in the STEM program. Although she conveyed her current situation is fine, my hope is she will value and find new avenues for community support at her new institution.

Knowing Sofia's strong determination and desire for challenge, it was a bit surprising that although she placed into calculus and started the class as a first-year student, she dropped calculus and enrolled in pre-calculus. She took Calculus in high school, but fell behind in college calculus, since she missed the summer prep for calculus as part of the STEM program she participated. Despite starting with a lower math class, she had high levels of self-belief in her math abilities. Sofia did well in her math courses, despite vastly differing perspectives on instruction styles and experiences. For her first semester, Sofia had an instructor who did not care about student success, contrasting with her second semester instructor, who integrated a student success community culture.

Lucia

Lucia did not have a good experience in high school where she witnessed a lot of drug issues and most of her friends not continuing to college. One of her stories about being first-generation focused on the college application process.

They tell you how it is supposed to be, but you don't know how the schools are and that you are supposed to take the ACT, or there is a deadline or that you have to apply for financial aid. A lot of things that you never knew, it's kind of like you are walking on a path without any light. You are walking because there is nowhere else to go, and you just deal with it—that's how I got to college.

Lucia is from Columbia and moved to the United States seven years ago with her

mother, while many of her other family members stayed in Columbia. She wished for more family support than she had.

I've had a lot of struggles. My family not being around me—it's a different culture so you have to get used to it and there is not enough support for you to tell someone you need help. So, you have to do it yourself. Your mom is working all the time so you can't rely on her the way you would want to.

I was glad that Lucia participated in a program to support the success of first-generation students, since she did not have a lot of support from her local family and friends. Lucia values support from others and was especially appreciative of participating in a support program.

I think that, you know, being a first-generation student actually helped me in the class. I joined a few programs in which they gave me scholarships, but they not only give you scholarships, they do a lot of workshops and they give a lot of tutoring and services. So, being a first time, first-generation student actually gave me a lot of opportunities to take advantage of, and just have a lot of support from every person that I needed.

What was remarkable about Lucia's story was the transformation of her negative experiences in high school math to college, where she developed strong self-beliefs in her mathematic abilities. It was somewhat ironic that she was a strong high school student in the honors program taking AP courses sharing that academics came easy to her, but she did not like or excel in math.

Well, it was amazing honestly. I think this is the first time that I took a math course in which I actually understood and did practically pretty well on the course. When I was in high school, I took so many math courses, but at the end my final grade was like a C or maybe even a D. Though this was the first [college]course that I got a final grade which I

was happy with 'cause it showed that I made a lot of progress and I think the professor and the resources that I had, had a huge impact on my performance on the course.

I think Lucia made the right decision to take pre-calculus, even though she placed into calculus. She did well in pre-calculus and then got a C in calculus which may have been partially impacted by having to miss several weeks of class for personal reasons. She plans to take the course again during summer 2018. Lucia seems to have the commitment to do well in math to continue her goal majoring in biochemistry and becoming a doctor, while dealing with stereotypes as a woman in STEM.

Ben

Ben described himself as hard working for things he enjoys, lazy for things that bore him, disorganized, witty, artistic, and social with people who he knows. His differential levels of working showed up with 'slacking off' in some of his high school math courses, but placing into college calculus.

His positive experiences in high school were difficult to let go, while adjusting to the new experiences in college. For instance, Ben had a strong affinity to being a student athlete and it was difficult for him to no longer be wrestling. Continuing to help with the wrestling team was a way he could keep some connection. Ben was also involved in robotics in high school, so his continued job teaching robotics at a middle school was meaningful. At least at this point in time, his main rationale for attending college is a means to become an engineer, and he did not see a reason to get involved in college both with others in the classroom or with co-curricular activities.

As a first-year student, even though he was initially confident in his math ability, I do not think Ben was developmentally ready for the independent learning required to be successful in calculus.

I guess my biggest challenge is sitting down and studying in doing work for a class that isn't mandatory. My calc class, he assigns homework, but he only grades the tests. That kinda like gets you not to do it because the grade doesn't matter, but if you don't do it you probably won't do it and fail the test. A biggest challenge is really studying when you don't technically have to.

After he failed the course, it was an extreme challenge to connect with him for his second interview, which I think was based on the shame he felt with his performance. Ben also talked about the pressure of disappointing his mother. In reflecting on his experience, he shared he had mixed feeling about his math abilities in being good at math, and not being as good as he thought he was.

My first calc exam that I took. I'm usually good at math and this is my first year and I wasn't sure kinda like it was taken as a surprise. Since I was good at math I didn't study how I was supposed to. I freaked out two days before the exam and I didn't understand the stuff, so I spent the whole night studying before the test and I got to the test and I still didn't know half the stuff. That was a bad experience. I didn't feel like I wasn't good enough for the class, even though I had done the first few tests. I was catching up. I guess it was too much of a bad beginning to make up for.... Since I'm generally good at math I guess I didn't prepare myself enough. My main problem was the professor.

When talking about his challenges in math, Ben shared:

I guess it would just be that the whole process of failing my first math class in college. I was good at math and then I failed my first math class ... I'm not as good as I think.

Ben passed calculus the following semester, and shared that his key to success was putting in the effort. I think he was developmentally more prepared and ready to succeed the second semester. Although his change in behavior seems so basic on the surface level, I wonder if more structured feedback and accountability in his fall semester calculus course would have provided the support for a better outcome, especially as a first semester first year student.

Martin

Martin was born in Cuba and came to the United States when he was five years old. He has an older brother who started college, but did not finish. Passionate about studying computer engineering, Martin was in honors in high school. I enjoyed his colorful personality, which he described as funny, outgoing, not politically correct (being very out there), trustworthy, and there for his family. He talked about the solitude he felt as a first-generation student.

It's just that being the first one into college, your parents don't really know ... Even if you are in college, you're not really supposed to ask your parents for help on anything. Just being the first one to step foot into such advanced math classes, it just feels very like you were held back a little bit. I don't wanna say held back, but I don't really know how to word it in that kinda sense. So, it just feels like a sense of solitude in that kinda way.

Despite the isolation Martin felt as a first-generation student, he felt his identities were accepted at this institution.

One of the good sides of it is no matter how diverse you are, like your identity doesn't stop you from learning in class or something. Like me being gay and Latino. Here, it's

not that bad; whereas, if I'm somewhere else in the country, I might be worried about who I am, rather than trying to learn math.

Concerning his perspectives on college, Martin was keenly aware of the benefits of a college education illustrating the benefit as "becoming more aware of life and how it is, the perspective on life." Focusing on experiences in his math classes, unfortunately he had drastic differences in instruction and course formats.

And like, noticing back on it now, every math class is so different. For example, the first two math classes I had, the whole hours and the ... yeah, just the whole hand-holding. And then Trig, just coming to class, lecturing, and then doing the tests. And then the tests make up most of your score. And then in Pre-Cal, I had the whole group thing, which I think was the most effective one. And then back in Calc now, it's just like the whole coming to class, lecturing, and then just doing a test.

Martin was reliant on external factors to define his learning, so this variation of course instruction was challenging for him. For instance, he did not like the transition from the structured support in Intermediate Algebra and College Algebra compared to the other pre-calculus courses.

You had to complete them in three hours at the lab, and then you would have to go to class, and then that big auditorium, and then it was really a lot of steps instead of just doing it by yourself. So, then you get attached to this kind of hand-holding, of going to the lab for three hours, and then going to lab to take your quizzes, take your tests.

Whereas, when you're thrown into Pre-Cal, you gotta do these things all on your own.

Additionally, his relationship with the instructor made a big difference in his math courses. In Pre-calculus, he had a great experience, which he attributed to the positive connection with his teacher and knowing she believed in him.

Pre-calc- I especially owe it ... I really owe it to my teacher. She was just amazing the entire time. I really owe it to her that I passed the class. I actually passed with an A minus.

He did not have a good experience in Trigonometry and Calculus I, and again attributed the experiences with the teacher.

Something that negatively impacted me again is just ... just the teacher. Who was just there, like show up, and then teach. And then expect you to learn, like, I didn't really get a lot from that.

I am concerned about Martin because even though he is very focused on being an engineer, he has not been admitted to the engineering program after two years of college. He got a D in Calculus I, while spending about two hours a week studying. I think he needs to reflect on the time and effort needed to achieve his goals.

Diego

Diego is hands down the most involved student in co-curricular activities in this study. He is a Pre-med student in the Honors College, and very involved on campus as a learning assistant, and organizations including Chemical Society (President), Phi Delta Epsilon (medical fraternity), Council for Student Organizations (approve funding), Neighborhood Health Program (help create local gardens), and Student Health Advocates for Education (promote safe sex). It was also very evident that he was extremely motivated. In high school, he was not good in

English, so during the summer he checked 20 books from the library and read constantly to improve his skills.

Diego was born in Peru and came to the United States when he was one year old. Being a role model for his younger brother, support for his family, and showing his family that moving to the United States was a smart move was motivating to him.

Being first-generation shows I want to go out and help and show what I can do. I have a little brother, too, and he wants to be just like me. I do everything I can to show him that there are opportunities everywhere.

He was also especially appreciative of his mother's support.

My mom most of all, she is always there for me no matter what. Sometimes I rarely sleep; I need to understand the concepts to get A's on everything. When I'm tired and hungry, my mom is there by my side. This one time I was like it was the summer I was taking ten credits and I was breaking down. I'm going to have to drop a class. She said no son in Spanish, you can do it, you are intelligent. She helped me through it. I finished all my classes with A's.

Diego focused on the benefits of being a first-generation student.

But for being first-generation, I wouldn't say this was a downfall or an obstacle. I think for me as a person, and any other student, we strive to do our best. We struggle, obviously, and we don't put any titles or names in front of us, we just try going around and solving. Try to do our best overall.

Diego placed into pre-calculus, but decided to take pre-calculus and trig together since he was close to placing into the combined course. In Calculus I, he did well working extensively with other students, the learning assistant, and utilizing tutors on a daily basis. He struggled in

Calculus II although he seemed to put forth the effort (studying between 30-33 hours a week, and studying with other students). He ended up dropping the course, but still attended the lectures, and wished the instructor had practice problems, quizzes, and a math lab. It was disheartening to see his self-belief in math decrease as part of this experience.

My hopes and aspirations just dropped so quickly. Like I used to love math, and then when I got here I was like, “Wow, I’m kind of like disliking math now.”

Even though Diego is experiencing a difficult time, I think his dedication and perseverance will get him through Calculus II next semester.

Victoria

Victoria highlighted not only being first in her family to pursue a career instead of a job, but also being the first woman in STEM. As a biology major, she is working toward Dental School, with back up career possibilities in either genetics or dermatology. She described herself as determined, competitive, hopeful, and hard headed. Her high school experience was unique from the other students, since she went to a charter high school with many students whose parents were professors. As an only child, Victoria shared her parents were the most influential to her and showed their pride by buying university apparel. Victoria shared her experiences in college as an opportunity.

It is an opportunity to be represented as an underclass being Hispanic and first-generation. It gives me an opportunity to shine with the others.

As part of her opportunity to pursue a collegiate degree, Victoria conveyed challenges to her self-belief as a woman studying math in high school, and how it has evolved in college.

In high school, me being a woman, I got told by all my math professors that me being a woman just meant that I would not be good at math. Like straight up to my face....

Because they were like, you're just a girl and girls statistically do worse in math. So that didn't really help.But now, I'm like, oh, okay. I got over that fear... Before I'd be like, I would look at the problems and be like, I just can't do math. I just can't do it. But now I'm like, oh, okay, I can do it. Like, I'll learn it.

When asked what changed her perception, Victoria responded that having more females than males in her math courses and a female instructor for College Algebra influenced this change.

Seeing women teach math. Which I had, because all my professors for math, over there they were all male. And then here my first semester was like, a woman. And she was super nice and she taught me like algebra from scratch and I actually knew how to do it. Yeah. And she's like, one of the lead ones in like, the math lab. So, I was like, okay it's doable.

Although she was proud she received a B in the Trigonometry and Pre-calculus class, before she started calculus she was unsure she had the necessary skills. Unfortunately, Victoria did not pass Calculus I the first semester. Her disappointing performance at the beginning of the semester caused her to not want to go to class, so she skipped a few lectures. She also did not have any connections with students, which she said was because they were adult learners with jobs and different life circumstances. Victoria shared the course was mostly lecture with no quizzes and she did not do the homework because it was not mandatory. Her reactions seemed based on a mixture of a lack of self-belief, shame, and low motivation at times.

Nervous (perspective about calculus) maybe I passed trig because I was lucky, maybe the professor just passed me. Like, I remember when I first like saw the F. I was like oh my God, unbelievable, you got an F. And then it really hit me when I saw my GPA just drop. Like oh my God that's it. Like, I'm not gonna go into any dental schools. There is no

way I can get it back up. But then I was like no you can always like you know, there is always the forgiveness policy, and not even that, but like just retaking it and just like moving on ... also and like your kind of like stuck in a gridlock, also because of it, you're like I never want to take Calc again. But for me to take my next class I needed Calc as a pre-req. So, I'm like what I kind of just have to like swallow it down and do it again. I feel like I could've just used more practice or like have maybe more options to rely on, like quizzes or something to like just check what I knew and what I didn't.

What made Victoria's experience in this class more complex was the challenges of being a low-income student and feeling she could not drop the class, even if she was struggling.

Other people are just like, oh yeah I'm just gonna drop my math class and try again next semester. Like, I can't. My financial aid is covering it ... I was like, okay I'll just drop it like I have to drop it or I fail. And then it hit me you have to pay back the \$500 we gave you. And I was like, the money is already gone. So, I had to like pull it out ... and just take it.

During the next semester in calculus, Victoria had a study group which she called the Dream Team. They had worked together in chemistry and she was very animated and positive when she spoke about the benefits of this group.

Influential in my Calculus class, is maybe like my lab partners. Because I took the class with, I took chemistry lab with them and we were like one of the best groups. We got the highest A in the class. And so they were like, oh yeah, we're like the Dream Team.

Victoria's engagement in class gave her the competence to be able to practice on her own after class, which may have been part of her issues first semester of not understanding the material sufficiently from the lecture to complete the homework.

Victoria passed her calculus course the second time and attributed her success to putting in the effort and practicing the problems. The support Victoria received from her math instructor and her peers was imperative to promote her self-belief and success in math, along with group learning, quizzes, and graded homework that she experienced when she took Calculus the second time. Just like Ben, I wonder if she had group learning and structured feedback with quizzes or homework in Calculus during the fall semester, if she would have had a better outcome.

Isabella

Isabella's passion for learning and desire to contribute to society was inspiring. When I first talked to her, she was majoring in environmental studies with a minor in philosophy and interested in environmental law. Then, she decided to change to engineering so she could construct sustainable buildings, which she believed would have a more societal impact than environmental policies.

Her self-reported identities are Hispanic, Cuban, woman, first-generation, big sister, and student. Isabella is open to different perspectives and persistent with the caveat that sometimes she loses motivation, but gets it back. She is also positive, honest, hardworking, and loves knowledge. She was born in Cuba, came to the United States when she was seven, and has family responsibilities with two younger sisters, along with two to three part-time jobs.

Her mother and grandmother were most influential to Isabella, and her outlook on being first-generation related to their hopes.

I think just being first-generation is enough to kind of motivate you to try do better, because you want to make sure the rest of your family knows they can go to school and they can surpass their initial expectations.

Additionally, although she often did not share the details of her college experiences with her family, she believed their advice was helpful.

They [my family] give me some advice. They might not know much about college, but they know things about life and they help me with this. They help me to make better decisions than a lot of people make.

Her family support extended to feeling supported in college with her identities.

We don't feel like we're out of place because here at [Research University] there's just a huge variety of students and ethnicities and backgrounds. Whereas, I have heard that if you go up North, then some people might feel stranger, more isolated.

Throughout discussions with Isabella, her predominate issue was balancing all of her responsibilities. On the one hand, one of her proudest accomplishments was taking seven classes in one semester while working. On the other hand, her biggest discouragement was a lack of time, which I think at times impacted her motivation. She is interested in learning so many disciplines and loves college, but faces financial obligations and childcare responsibilities, along with being distracted by her younger siblings when trying to focus on studying.

Concerning Isabella's experience with math, she believed she did not receive a good math foundation in high school. She started out in international relations, which was a non-calculus-based math track. She changed to pursue engineering, and retook algebra even though she placed into pre-calculus, which was a testimony to her value of making sure she mastered the content. Isabella did well in Calculus I, receiving a B. She attributed her success to a caring instructor who had graded homework, quizzes, course worksheets and videos, along with support and work with classmates. Unfortunately, although Isabella had the same instructor for Calculus II, she did not pass the course. Isabella had two jobs at the beginning of the semester. After

receiving a 66% on her first exam, she dropped one job. Surprisingly, although she improved on the second exam, she decided to focus on her other courses and did not take the last two exams in the course. It was disappointing to learn of this outcome, because I think she has the ability to succeed. At least in the spring semester, her other responsibilities impacted her negatively.

Summary

Although all the students in this study were first-generation, low-income, students of color in STEM, this student group provided a range of experiences and perspectives in terms of years in college, math pathways, co-curricular involvement, connection to the institution, involvement in support programs for underrepresented students, and successful outcomes in math courses. These varied perspectives and experiences add to current research on underrepresented students mostly focused on first-year students, often involved in support programs.

Throughout their stories, assets of first-generation, low-income, students of color were illustrated. These assets focused on motivation or desire to achieve something, drive or determination to obtain a goal, and self-reliance, which require relying on one's own resources. These assets are all closely related to self-belief, a belief in achieving one's goals. Other assets included being a role model for the family and having the opportunity to become involved with support programs. Overall, these students had a fairly strong sense of self-belief they would succeed in math.

Along with these assets, students dealt with stereotype threats of their identities by sharing they were 'underclass' compared to 'others' and viewed as a negative statistic. Assumptions that being Hispanic implied limitations with academic competency, language, and being first in the family to attend college; and discrimination as a woman in STEM were other

threats. They also conveyed the challenges of their families not able to share information about the specifics of entering and succeeding in college.

It was empowering to learn that even though these students felt the challenges of these oppressed identities, they often shared their identities were accepted at Research University, and their families strongly supported them obtaining a college education. The institutional support could have been the result of demographics with a majority of students of color, large percentages of first-generation and Pell Grant eligible students, and the institutional priority in supporting student success. The support of Research University along with the students' assets of motivation, drive, and resilience, and their family support to obtain a college education worked together to create a positive synergy to counter balance some of these students' negative perceptions.

Building upon the institutional context, student profiles, and stories, the next chapter illustrates five common themes determined from these student experiences with college, specifically with math placement and math courses. These themes include:

- 1) Appreciate attending college and feeling pressure to succeed.
- 2) Determine math intelligence.
- 3) Transform to engaged math learners.
- 4) Thrive in an inclusive classroom.
- 5) Support for success in math.

CHAPTER 5: FINDINGS

Expanding beyond the institutional and student context, five themes were determined from the insights of eight first-generation, low-income, students of color taking pre-calculus and calculus courses. These findings are in response to the research questions guiding this study.

1. How do college first-generation, low-income, students of color experience math placement and pre-calculus/calculus mathematics courses?
2. What university factors influence the self-belief of college first-generation, low-income, students of color for success in math?

These five themes provide a framework of student experiences that impacted self-belief for success in math. They include appreciate attending college and feeling pressure to succeed, determine math intelligence, transform to engaged math learners, thrive in an inclusive classroom, and support success in math. Each theme will be expanded with illustrations and student outcomes will be conveyed. In Chapter 6, these themes will be discussed along with an analysis of self-belief theories as the theoretical framework of this study.

Appreciate Attending College and Feeling Pressure to Succeed

During the focus groups, these students described themselves as unique, proud, privileged, hard-working, dedicated, pressured, and stressed. These descriptors highlight the overall theme for these student experiences as appreciating the opportunity to attend college, which came with tremendous pressure to be successful.

This appreciation was described as being fortunate to attend college, since many of their family members did not have this opportunity. Lucas shared:

Being a first gen student has taught me that not everybody has the opportunity to go to school, because I have a cousin who recently came here from Vietnam who hasn't had

the ability to go to school, and wishes and loves to go to school. I really took pride in this because me being able to go to school as a first gen and seeing what I can do, really showed the progress that my family has made in transition from Vietnam to America.

Lucas also appreciated receiving funds to support college expenses, which allowed him the opportunity for a career.

I didn't have to concern myself with any money situations and with the Pell Grant, it gave me an extra boost because I saw that, wow, people are giving me money to actually go to college, and do what I have to do to be able to be a good citizen in the society, for the future. I'll probably have a career that I would like to do. And I saw that it was really, really helpful.

These students not only had great appreciation for the opportunity to attend college, but they also had a deep understanding for the value of a college education. Diego said:

When I got here, when you see the big difference how important it is, it is more pressure in a sense. I always wanted to learn to understand and to be able to communicate, do math, music, or any of the sorts. There is beauty in understanding and talking to others about their ideas.

Lucas viewed the benefits of college for himself and his family.

I'm actually proud of this achievement because it's put me at a higher standard because I'm not a statistic anymore. I'm able to grow beyond that, which would really help my family, because they always have looked at blue collar work as the highest degree that you can get. Being able to go to college is great for me because it will help me a lot in the future and it will help me cuz I have three other siblings who are younger than me.

This will help me as an older brother. They will see me as a role model and follow in my footsteps, being able to go to college.

Along with this appreciation came daunting pressure from the demands of multiple responsibilities and pressure from family. During the focus group, students discussed this pressure with great intensity. Isabella shared:

You start working forty hours per week or more so that you can have enough money to then get back to school. So, it's like you don't really have a break... you don't have time for anything, so it just feels like you don't really have a life.... You have to be at this constant numb feeling. Because if you get too happy, then you're not going to be happy, while you're doing the things that you have to do.

Ben talked about the pressure from his family which stemmed from their pride.

It's a lot of pressure and your family sees you are in college. They expect you to do great things and never mess up, always be on your stuff. Since they haven't been to college they don't understand the worries..... They have never been at college, but it is a lot of pressure, it's nice to make your parents and family proud that all of their hard work was for a reason.

Martin felt pressure from his family resulting from the sacrifices his parents made to move to the United States and provide the opportunity for him to attend college.

It is very important and a lot of pressure. I did have a brother who went to college and he didn't succeed. So, now it's even more pressure. My parents expect me to go to school, get a job, and make a lot of money. But it is a lot of pressure from me to give back to them, cuz they brought me here and made sacrifices for me.

Combining this opportunity with pressure, these students acknowledged themselves as full of potential.

Determine Math Intelligence

Beyond these students' perceptions of attending college, students in this study viewed the math placement exam as high stakes and one that would determine their math intelligence, consequently, creating a lot of anxiety. This deep concern seemed to conflict with discovering that most of them did little to prepare for the exam. Overall, the process and outcomes of the math placement exam did not positively impact student's self-belief in math.

The pressure of the math placement was widespread among the student participants. Ben shared the pressure being in a STEM major along with the financial implications of having to pay for additional math classes.

I definitely felt pressure. ...with the engineering curriculum the Pre-calc is a lower class not in the curriculum that adds excessive credits. I didn't want to take that class. It was very important to me to score high. Just one test to see if you are smart enough, that two-three classes that I won't have to take. I was pretty nervous about it.

Martin reinforced this pressure, sharing the placement exam was very stressful because it decides your fate in math.

This pressure was compounded by an ethical dilemma of whether to cheat on the on-line exam, which several shared they cheated or attempted to cheat without great results. Victoria said:

I was really scared to take it because people were like take it at home in case you need to cheat. Cheat cuz you need to be placed as high as possible because it takes you years of college. Go as much as you can and use a cheat sheet. And I was like no, because if I get

put in calculus, I don't know what I'm doing. I was bad at math in high school. But then you take it honestly and if I need to scratch everything off, I want to start off with a clean slate.

Even though students were anxious about the placement exam, most of the students didn't study prior to taking the exam. However, the rationale for this lack of preparation was more than not valuing the exam. A couple of students shared they wanted an accurate reflection of their ability, Ben shared that math was second nature so he thought he would be fine. Martin didn't know what to expect or how to prepare.

In high school I didn't know a lot about math. I said the classes there weren't very helpful and I didn't know what to expect for math college class. So, I didn't really prepare myself for it. I think I'm fine and I'm just going to do it, but I didn't realize the big leap. Had I known, I would have probably taken more steps.

For the couple of students who did prepare for the exam, they used notes from high school courses, and ALEX (math placement exam) and SAT study guides.

Students shared their identities impacted their experience with the math placement by having high expectations and drive as a first-generation student, wishing their parents could have warned them about the exam, and not having the resources for SAT review courses, which they thought would benefit their math placement performance. Concerning the math placement results, students in this study ranged from placing into remedial Intermediate Algebra (one student), College Algebra (one student), Pre-Calculus (three students), and Calculus (three students). Overall, the reactions to the placement exam results varied with this group of students. Some students were upset and frustrated. Martin shared:

It was frustrating cuz I knew that I placed in the lowest class and knowing that I had to work my way up to get through school. It was a little frustrating. I couldn't blame myself because I didn't know.

On the other hand, Isabella shared that when she was taking the exam, "I thought I was going to score terribly. I'm not going to well at this at all." After the exam, she said, "The fact that I scored higher made me feel that I can do math."

Considering the effectiveness of the math placement exam, half of the students enrolled in courses different than their math placement results. Three students placed higher on the placement exam than the math course they chose to enroll. One student enrolled in a course higher than his placement, noting his score was only slightly below the cutoff score. The other students thought the placement was accurate even though one of these students didn't pass the course his first semester. It should be noted that the students who enrolled in a lower level math course than their math placement result, were all female.

In reflecting on these findings, it is important to note the barrier of stereotype threat is well-documented to negatively impact math performance. This threat seems even more plausible when learning how deeply these students cared about their math placement. It is also interesting there was no value on practicing and preparing for the exam, which is integral to be an engaged learner or having a growth mindset. Actually, student perspectives on the placement exam process often reinforced a fixed mindset of a point in time to determine your intelligence in math, such as thinking "one test determines if you are smart enough," "wanting the exam to be an accurate reflection of my ability," and "not needing to study because I am good at math." For this group of students, this fixed perspective is contrary to how we want students to be introduced to learning college math.

When considering other overall aspects of self-belief, the math placement process did not include components that promote self-belief, such as receiving messages of support, observing other students' experiences, and having the opportunity to gain mastery. For instance, the on-line communication about the math placement was focused on mechanics and logistics, without a lot of support structures or messages of encouragement and support. Additionally, since the math placement exam is a solitary experience, there are no opportunities for support from other students. Along this same line, Isabella shared the placement was not accurate for her (she thought it was too high) because she was not working with other students to see the gaps of knowledge.

I think the exam is well made, and I think the fact I got Pre-calc but wasn't ready for it was because it's not the same to go through the exam, like if you could sit down with students you could find more gaps.

Finally, there were few opportunities to gain mastery, such as practice exams or the opportunity to continue to work on your placement rather than it being a final score after one exam. Perhaps the anxiety that some students felt with this high stakes math placement exam combined with the lack of support structures prompts students to think about cheating on the exam. Overall, the math placement experiences were somewhat traumatic and for half of the students, the results were not an accurate compared to the courses they enrolled.

Transform to Engaged Math Learners

Different from the math placement experiences, students were expanding and enhancing their engaged learning with experiences in taking math courses. To define engaged learning, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning (Great Schools Partnership, n.d.).

The transformation as engaged math learners centered around the value of practicing, devoting time and effort, gaining mastery with mathematical concepts, working with other students in study groups outside of class, and obtaining a stronger understanding of the value of requesting help. Throughout their interviews, the students expressed a strong appreciation of how these factors influenced their beliefs in success in math, and how their learning evolved with more experience in college.

Value of Practice

The value of practicing as an example of having a growth mindset was based on the perspective that practicing was especially integral for math courses, and practicing problems promoted self-belief and successful outcomes. First, students emphasized that math is different from other subjects requiring intensive, consistent efforts with hands on practice, contrasting with reading and memorization required in other disciplines. Lucas illustrates this theme.

Math isn't something based off memorization like other courses like biology.... like world history..... It's way different. It's something that you have to do, it's more of a hands on, write it on a piece of paper and the more times you do it, the more successful you become, better at it.

Lucas also shared how practice was connected with self-belief.

I don't really see that many complications for the concepts or anything, it's just believing in yourself and practicing as much as you can. And I can use that skill from math just everyday life-to-life, and it's pretty cool. You don't learn enough from math. You think just numbers and stuff, but you learn self-satisfaction and self-belief and stuff from math.

Finally, Victoria shared how practice was related in successful outcomes in math.

I used to hate math. I used to never want to do any math problems and now I work hard.

I practice a lot because math is a lot of practice, and I put a lot of effort into learning so I think it's important that if you put in 100% and work hard you will see results. And that is what I'm getting right now.

Devote Time and Effort

Along with practice, students gained a stronger appreciation during the college year about the importance of placing effort and becoming engaged in the learning process, illustrating a growth mindset. Lucas shared:

Because normally I wouldn't put in that much effort as I normally do. I would put in, I'd say before that first semester [as a first year college student], I'd put in maybe 60%, but this semester I actually put in a lot, around 85-90%, and I saw like, "Oh wow." Putting in much effort gives me a better outcome than I expected, because before I would just rely on luck and maybe I will be able to pass this test for that. But this semester I saw through Pre-calc that I was able to go to the lab and practice what I need to practice, and get better at it. And I saw that I became better throughout the course.

Lucia reinforced you must spend a lot of time in calculus.

You need to have good time management skills and it has to do with a lot of effort. It's not going to come easy. There's still a lot of rules and materials to cover, and just two hours of class. And you can't pass the class if you don't go home and just read the chapters over and over again, because it's impossible. It's just too much information. So, I think one of the things to be successful in math is to spend a lot of time, dedication and effort into it.

Lucas shared that it was somewhat of a revelation to discover his practice paid off.

Overall, the course isn't bad because it's more of your effort and how much work you can put in. Actually, through that course, I was able to find out a little thing about myself. If I actually put in that work, I can actually learn the material and be proud of myself because I was able to learn all that material, practice for the test, and do all the work necessary for the course.

Although as researchers and practitioners, we think practicing and effort is rather obvious in being successful in math, these student perspectives suggest it is a process for college students to realize and appreciate the importance and connection between effort and success. As Lucia shared:

Putting more time with math is just getting used to college. You go to something completely different, so your whole life changes. It's a matter of getting used to the whole setting of college and then improving.

Gain Mastery with Mathematical Concepts

A part of engaged learning and self-efficacy is mastery experiences, which students conveyed as knowing concepts on the top of my head and being able to illustrate them on paper, solving a problem, understanding a concept and then being able to practice on my own, knowing I was going to do well on my first exam, doing well on the first exam, and teaching concepts to other students. For instance, Isabella shared that getting an 81% on her first exam made her feel she could do math. Lucas shared about the persistence needed when completing math work.

I mean there were more times when I was doing my labs plus and the work was complicated. I was super tired from one of the classes in the morning and then when I come, and I just told myself why I did this, negatively self-doubting myself. But, I get

this sense of pride every time I go through a problem, and as I'm working towards that 100%, I saw it's being able to overcome the hill. Because when you start a problem or something, you're at the base of the hill. You're behind that hill and you need to get over that hill till you become more ... so that you're able to get over it. As I saw that, that it's just being able to get over a hunch and working towards what you want. That's when I increased my self-confidence. Oh, I can do this. So, satisfaction that you just need to do this so you can be able to do what you want.

Another theme of the interviews and the focus groups was the mastery that came with teaching math concepts to other students. Diego shared:

They'd teach me like, "Oh, you need to do this and that." Inform me of the rules; you can think this way, that way. They really helped me out and I had them also for another class too, which was for chemistry class. Which I helped them with, because I'm really good at chemistry. I got like a 100 on my exams. So, I helped them with that, which they struggled in. So, it was kind of like a give and take. We help each other out, we back each other up.

Finally, Lucia spoke of the positive outcomes in the course that created self-efficacy in mathematics.

Well, it was amazing honestly, I think this is the first time I took a math course in which I actually understood and did practically pretty well in the course. When I was in high school, I took so many math courses, but at the end my final grade was like a C or maybe even a D.... Though this was the first course that I got a final grade which I was happy with, cause it showed that I made a lot of progress and I think the professor and the

resources that I used, had a huge impact on my performance on the course. I got a B as the final grade.

Work with Other Students

Along with spending time and effort in math courses and having mastery experiences, taking time to learn with other students was a powerful mechanism for these engaged learners, which also promoted self-belief. A part of increasing self-efficacy is vicarious experiences or seeing people modeling their success. This concept was reinforced in this study, since most students, including Lucia, articulated value in working with their peers.

I met this group of people that you know, they were the same as me like they struggle with math. I think we all pushed each other to be better in the course and to set up times and days to study with other people, and just try to teach each other and understand the concepts even more.

Another aspect of working with other students was receiving help when they were struggling, which Diego shared, also normalized they were not the only one struggling.

That first exam hit us hard, and now we're spending even more time and effort. So maybe failing exams makes us stronger overall. But I don't know...we're all out here struggling, you know.

Studying together also provided an opportunity to learn different approaches or illustrate alternate explanations to solving problems, as well as a venue to check solutions.

A few students, such as Victoria, valued working with other students' only part of the time or would rather study on their own, with the rationale of not having sufficient time with other commitments.

A little bit of both, because sometimes I feel like if I study with someone else and they don't know it, if I explain it like I know I'm doing it well. Sometimes I'm like, I'd rather just do it myself because I can go faster, not like slow me down.

On the other hand, Ben rarely worked with other students.

Like I say I work by myself mostly. And especially with school I have to work and stuff, so I don't really have time to meet up with people who are only students, you know.

Lucas changed his perceptions of studying with other students. During his first interview, he shared:

I don't see the point in practicing in groups for math because it's more you just have to learn it by yourself; you just have to do it.

During the focus group at the end of his first year he changed his perspective.

Math isn't like an everyday language where you can talk about it. So, like you have to talk with your peers and see what their perception of what this math is, so they can teach it to you like in an easier way.

Concerning the characteristics of the study group, most students met students in other courses, such as chemistry and English, and continued these connections in math. Friends were also a primary source of developing study groups. Leadership in the group was determined by who understood the concept the most. The amount of study time together ranged from right before the exam to two-three times a week. Working with other students also helped motivate them to go to class or finish homework.

Seek Help

Aspects of asking for help included building confidence to request help and realizing that getting assistance was beneficial. Lucas's perspectives about requesting help evolved to feel more confident about asking questions.

When I was first in high school, in freshmen year, I was really shy. So, I didn't ask for help because I had a sense of pride that asking for help was at a lower level. But, as I gradually became older and more mature, I saw that even asking for a little bit of help is really good for you. So, I'm way different now than I was before. During the middle of a lecture, I will ask a question if I don't understand it. This has come a long way because I've been a really shy person and insecure about asking for help, but now it's totally different.

Sofia transitioned from being independent to becoming more interdependent in seeking assistance.

I had to stick it out and learned on my own most of the time..... It was a bit frustrating at times. But sometimes it was kind of just, okay. I felt really independent. It was nice at first, but then, towards the end, I was just kind of, I really need someone to understand what I'm doing.

Taking the time and effort to seek assistance is a testimony of transforming into a more engaged learner. In summary, individually, students gained a stronger appreciation of practicing and effort. As members of the college community, they appreciated the evolution to be more interdependent in working with other students, and instructors.

Thrive in an Inclusive Classroom

As college students transform into more engaged learners, faculty practicing inclusive pedagogy are further promoting student learning and success. Inclusive pedagogies in the classroom that influences student's self-belief for success in math in this study included active group learning, diverse experiences and approaches, and a community of care.

Active Group Learning

The majority of the student participants preferred a course format that included group activities in class, with little preference for lecture as the primary mode of instruction. Miller (2005) describes the advantage of group work in teaching STEM is students working together to be successful in the course, with the opportunity to apply what they are learning. Martin shared the benefits of group work to learn from other students.

I was definitely a lot happier with groups....When I was in my Pre-calc class, we were all in groups of three or four and like there was always that one smarter person. They'll teach it to us and we'll understand it. And then they switch the groups up and eventually I was the smarter one, and then I could teach it to them.

Victoria saw the advantage of group work to gain an understanding of what she understood and what she needed to continue to work.

He gives group activities during like certain chapters, and he'll give like worksheets with four problems. But you figure them out in class and you talk to your neighbor and like you ask questions, if you don't get it, which has been helping me. I know exactly what I don't get and what I do get.

Conversely, Victoria described a course experience that didn't have this group learning approach.

I would literally walk into class and he would start teaching and lecturing and talking and I was like, “Oh, my God, he makes it sound so easy in class...but then as soon as I was like left on my own...I would not know what I was doing.

Diego had excelled in math up to Calculus II. Despite spending a lot of effort (thirty hours a week), he dropped the course and one of his reflections was wishing for the opportunity to have practice problems in class.

I really wish he could give us practice problems to work on in class, so we could ask for help. He does not do that at all. He just goes to the problem straightforward, drawing it. And he just goes find the averages like, I look around, we look at each other, we're like, “How do you get there?”... He goes so fast and then when we have questions, we're hesitant to ask cause we're like, we don't understand how he gets from point A to point B. Where he is now?

Diverse Experiences and Approaches

Along with active group learning, inclusive pedagogy concepts also incorporate respect for multiple perspectives, and varied experiences of a range of students in the classroom (Saunders & Kardia, 2011). These concepts were exemplified when Lucia highlighted in the quote below that it was impactful when instructors took time to explain concepts when students were struggling.

He wants people to learn. If he sees that someone is struggling, he takes the time and just tries to make you understand the best possible way. Like in class, if you're struggling, he observes the students, and you think he might not even notice that you're confused about something. Then he notices that you're confused and he tries to explain step-by-step everything he's doing. You feel comfortable in a class like that.

Students conveyed that different approaches to solving problems was helpful to their understanding, which happened with faculty, learning assistants, and other students. Victoria shared she understood the concepts better when the instructor was very redundant and approached problems in many different ways. Learning assistants, students trained to supplement instruction in a math course, were another source of varying approaches. Several students shared that when asking for help the learning assistant would often offer an approach to solving a problem that was different than the instructor, which helped in their learning. Finally, Martin shared that working with other students in the class provided another opportunity to learn about multiple ways to solve a math problem.

Being able to like, show others what you can do I guess it really helps because it reinforces what you learned, and I guess you can teach the others maybe like, tips or tricks on how you attack the problem, so that they can be able to see it in a different way. Because sometimes you look at a problem and you just look at it straightforward, but being able, like, from others to see they can see it from multiple angles.

Community of Care

Inclusive classrooms are classrooms in which instructors and students work together to create and sustain an environment where everyone feels safe, supported, and encouraged to express her or his views and concerns (Saunders & Kardia, 2011). Faculty creating a caring community was mentioned throughout the interviews as highly important for most students to feel they belonged in the math class and believed they would be successful. One example of a community of care that Lucas illustrated below are faculty responses to questions.

You know when an instructor cares. It's just when someone comes in with a smile and just knowing ... like even if you ask her any question, she takes the time to sit down with you and further explain something that you don't know clearly.

Another testimony to create a community of care that Martin shared, is knowing student names and relating on a personal level.

She knows your name instantly. She tries to remember your name, so that's very important. It's like the little things that she does to make a connection with us, and she's just very out there, very outgoing. She'll try to make a question that's not related to the class or something, like she'll ask you how your day was or something. It's just that personal connection that you have with her; where it's not just like teacher-student, but like two human beings trying to get along or something. She also would feel bad when students would score bad, or when they wouldn't take advantage of the resources. ... the fact that she was disappointed, you just knew that she really cared. She just had such a positive attitude, and a willingness like, make sure you learn material. She just had a love for math that ... I mean, I don't have a love for math, but hers was really contagious. I liked going to class, I liked seeing her, and I liked seeing her teach.

Lucia felt she experienced a caring community with having an instructor dedicated to student learning, and provided support and encouragement.

He offers a lot of help. So, when I go to his office hours, I see a lot of other students there, and we just have like a group study thing with them.... I mean, his office hours are sometimes from like three to five, but sometimes if it's necessary, he even stayed the other day until seven, two days before the exam. So, he puts more time than he has to, and he just offers a lot of help and a lot of comfort to me when I was in that situation. He

brought a lot of comfort into my life, and he just didn't put pressure on me. He just said, "It's okay. You don't have to make this such a huge deal in your life. It's just a subject. And it's fine if you don't feel comfortable right now, it's okay." It's something that you don't expect from a professor usually.

Building upon responding to questions, supporting learning, and being personable, one of the biggest affirmations of a community of care was faculty sharing they believed in students' potential for success. These verbal persuasions of significant others giving positive validation is one of the facets of self-efficacy, or believing you can achieve your goal of being successful in math. Lucia shared how she knew her faculty member believed in their success.

So, every week, sometimes he says, "Okay, you. What is the answer?" And then I say the answer confidently and just feel so good about it. He's like, "Yes! I feel so proud of you." He gives this rewarding face to every student who gets the correct answer... then he gives encouraging words for you to just keep going and keep trying.

Martin stated how impactful an instructor's belief is for him to succeed.

I feel like my teacher had expectations of me and that kind of stuff. And I feel like she knew that I could do it. And, just really having that one person that knew that I could do it was really important.

Along with faculty supporting a community of care, students were also a source of creating this community by checking with each other to ensure they were in class, forming study groups, and sharing struggles with the course, which normalized the challenges. Diego illustrates this student-to-student support.

Having other people, having the same majors there, and having my friends there as well.

Cuz we're supporting each other. Cuz we need this for our major, so we're kind of forced

to take it. But it's really good because we are struggling together. And when we do good, we all do good. And it's nice.

Simultaneously, as students evolve to become more engaged learners and instructors are creating inclusive classrooms to support student learning and success, additional support structures are included both in and out of the classroom, to further support student experiences in math.

Support for Success in Math

In addition to inclusive classroom pedagogies, support structures in the classroom, such as course feedback, can be impactful to self-belief. Supplementing instructor teaching practices are support structures, such as tutoring programs, learning assistants, and communication about campus resources, which also promote student self-belief and success.

Course Feedback

Chickering and Gamson (1987) illustrate best practices in undergraduate education, including the importance of having frequent opportunities to perform and reflect on what students still need to know. Within the classroom, the support structures that appeared most important to student success for Isabella was having graded homework and understanding why she got wrong answers on an exam.

The grading [homework] gave you that accountability that you needed. Even though it doesn't count for a lot in the grade itself, just the fact that it is a part of the grade, makes you want to complete the homework. Completing the homework helps you succeed in the exam.

I felt like the fact she took so much time on the exams, to correct the mistakes we made, that we could go up to her and ask her, Why did I get this wrong, or this or that. The fact

she provided the solutions online to the exams, after the fact, really helped. You're able to see why you got things wrong.

Lucas talked about the benefits of graded homework and quizzes for accountability and motivation.

So, for me, like just learning math without any homework or quizzes or anything, it's kind of hard for me to drive myself. Because when I have like a due date, it's way better for me to learn the material. I mean it's not better, but it just sets a point where like oh, I gotta go and learn this material. And it makes you like, work harder, even though you don't want to do it. You have to do it because in the end, work is work and you're going to have to learn the material. And I feel like that's better than without the quizzes and without the homework.

Math Lab and Learning Assistants

At the Research University, College Algebra had a Math Lab where students were required to spend three hours weekly to complete homework. Most students felt extremely positive about the Math Lab. Students shared it was a highlight in being tremendously helpful, and one student even said that it saved lives. Isabella appreciated the step-by-step structure and the learning assistant student staff.

My Labs Plus didn't only have the step-by-step, how to solve each problem, it also had people who would help you, if you're really stuck, which would happen. They make sure you do your homework and it helps you solve the problems. It may not help other students, but it helps me—the way they did it.

Victoria valued the weekly requirement for the Math Lab.

I wouldn't ask a lot of questions to the LA's [Learning Assistants]. I wouldn't really use them, but I like having that study space. I remember I had to do three hours a week of just going into the lab. It just forced me to dedicate at least three hours a week to do my homework.

Diego shared that he could connect with the learning assistants more easily than the professor and appreciated their understanding of the content.

On the other hand, Martin thought the requirements of the Math Lab were excessive and shared that the lab in lower level math courses created a hand holding structure that was challenging when this support was not available in pre-calculus courses. Several students thought it would be helpful to have the Math Lab incorporated into calculus courses.

Most students talked very highly of the learning assistants, especially in the Math Lab. The value of the learning assistants in calculus courses was more variable as described by Isabella.

But, it depends on the LA, whether they help or not because for Calc 1, I had an LA who stayed with a group studying until three a.m., but the LA for this class, Calc II, he had more things to do, I guess. He has things going on in his life, so he's not as helpful.

Other Support Resources and University Messaging

Additional resources students mentioned helpful for their belief and success in math were teaching assistants, Saturday exam reviews, tutoring, Multicultural Services, TRIO Student Success Services, First-Generation Student Support Program, and an interdisciplinary program with biology and math. Lucia was especially appreciative of these support programs.

Something that has promoted my self-belief is the help that I've gotten from all the resources that I attend. The people, the tutors, my professors, the advisors—it's the support that I need just to reassure myself that I'm capable of doing this. It's a tough class for a lot of people, but it's still something that is manageable, and that we're able to do it if we want to. So that's something that has promoted it.

Most students believed the university did a good job of communicating the resources to support their success. In the quote below, Sofia illustrates this support.

They definitely made sure you knew you had a lot of support. I still constantly receive emails from them, "Join this support group," or "Join this study group," or "Join this tutoring group." They made sure there were multiple societies or groups where you knew you could go for help with any private tutoring, public tutoring, group tutoring, and individual tutoring. They made sure you knew. But, it was kind of, up to you to take the initiative and go register for it.

Martin's shares his perspective that along with these messages, Research University should share the challenges of student success and how the institution is responding to these challenges.

The university, I just feel like they put so much effort on letting you know the good things, rather than the bad things, where the bad things are the more important things. Like they don't let you know that Pre-Calc has like a 64% passing rate, or something like that. I feel like that's important to know and to make an effort in it.

Student Outcomes

Based on self-reported grades, after the first semester most students received A's and B's with two students failing their math course. The student's in pre-calculus courses all earned A's and B's, and the calculus grades were mixed with one A, one B, and two F's. After the second

semester, six students shared their grades; one A in pre-calculus, and three C's, one D, and one F in calculus courses. One student dropped Calculus II, which was devastating to him, especially since he received a B in Calculus and had been spending 30 hours a week in Calculus II. He continued to attend the course after he dropped and plans on enrolling again.

In general, more students had better grades during the fall semester compared to the spring semester, and the grades in pre-calculus courses were higher than the calculus courses. It was interesting to note most of the students were taking or will take calculus as sophomores. Isabella, a junior, took math in the social sciences and then changed majors. Thus, she enrolled in the calculus courses later in her college experience. Ben was the only student who took calculus the first semester and did not pass the course. Concerning the timing of taking calculus, on the one hand, beginning calculus in the sophomore year may negatively impact degree progress in STEM majors, but on the other hand, first year students taking calculus who do not succeed is also an issue. More research on the timing and performance of calculus would be beneficial.

Summary

Illustrations of the stories of math experiences of the eight first-generation, low-income, students of color were conveyed to highlight the five themes that emerged in this research. These themes are appreciate attending college and feeling pressure to succeed, determine math intelligence, transform to engaged math learners, thrive in an inclusive classroom, and support for success in math. These themes provided a framework to illustrate an in-depth insight into the perspectives and experiences of these students, as well as identified instruction and institutional components that can positively impact student's self-belief for success in math. Chapter 6 will discuss the implications of these results as well as provide recommendations for future practice and research.

CHAPTER 6. DISCUSSION AND IMPLICATIONS

Chapter 6 discusses the findings from this study with related literature within the self-belief theoretical framework, in response to the research questions, 1) How do college first-generation, low-income, students of color experience math placement and pre-calculus/calculus mathematics courses? and 2) What university factors influence the self-belief of college first-generation, low-income, students of color for success in math?

The five themes that provide a framework to discuss student experiences that impacted self-belief to be successful in math are appreciate attending college and feeling pressure to succeed, determine math intelligence, transform to engaged math learners, thrive in an inclusive classroom, and support for success in math. Potential implications for universities interested in enhancing self-belief in math are incorporated throughout this chapter and summarized at the end of the chapter. A discussion about the theoretical framework is reviewed. Critique on the limitations and strengths of this research, recommendations for future study, and reflections on my research journey are also included.

College First-Generation, Low-income, Students of Color Identities

Focusing on students' perspectives about their generational, income, and ethnic/race identities, these students seem to be very aware of the meaning of first-generation, even though first-generation status has not been well-defined across the country. Perhaps this is due to the fact about half of the students at this institution are first-generation, which was somewhat different than the first-generation students I interviewed as part of the pilot study at an institution with a smaller percentage of first-generation students. Consequently, it is imperative institutions of higher education actively recruit, acknowledge, and support first-generation college students,

so these students have the opportunity to easily connect with other first-generation students on campuses.

Students in this study were knowledgeable about being a Pell Grant recipient, but there was minimal intentional messaging or institutional support for Pell Grant recipient students. They were proud to be Pell Grant recipients, appreciated the large amount of financial support, and saw this investment as a testimony in belief of their potential for success. Currently, many higher education staff are cautious about sharing Pell Grant recipient status, since it is an indicator of low-income status. Perhaps this paradigm could be explored further to consider how messaging and support could be enhanced as to encourage and support student success in college.

Part of being a Pell Grant recipient comes financial responsibility, also found by Martin (2012). For instance, in the Research University study, it was clear a big factor for not dropping a course was the cost, even if the student was struggling. Oftentimes, academic advisers may not fully appreciate the financial considerations to assist students in making decisions about dropping a course. Some institutions may not have policies and processes to assist with this dilemma. One possible strategy to address this issue is to offer courses that start mid-semester allowing a student to drop a course they are struggling in, and still use the tuition cost for another course that they can succeed and earn credit. Institutions must also provide education for advisers to be fully aware of the financial implications of course withdrawals.

A unique aspect of the race/ethnic background of students in this study was the majority of the students were either born in another country or had parents who were born in another country. The immigration experiences involved with transitioning to the United States most likely had a strong impact on these students' perspectives of the college experience. For

instance, their appreciation for attending college partially stemmed from knowing other family members who did not have this opportunity. This background could also positively impact self-belief, which Alessandria and Nelson (2005) found with first-generation students, who had at least one parent born outside the United States, had significantly higher levels of self-esteem than continuing-generation students.

Appreciate Attending College and Feeling Pressure to Succeed

The intersectionality of being a first-generation, low-income, student of color revealed the complexity of having assets, and being proud and appreciative of being a college student. However, they also were keenly aware of the pressure to do well in college. The assets these students shared regarding their identities were motivation, seen as a role model for the family, and self-reliance. These findings align with literature illustrating the intrinsic motivation of going to college (Lin, 2011; Prospero & Vohra-Gupta, 2007); desire to contribute to society, especially as a role model to siblings (Olive, 2009); and self-authorship (Pizzolato, 2003). The strong pressure these students felt to become successful in college was mirrored by Jehangir et al. (2015) findings.

Other Findings Related to the Literature

Related to the college experience are family support and cultural alignment between college and home values. Concerning family support, these students talked predominately about how they appreciated the emotional support, even though their family did not know the specifics of the college experience. The literature mostly talks about parents who did not attend college as not having the same levels of support for college students (Ward, 2012). This paradigm needs reframed to parents not having the same knowledge base, but having strong support, echoed in the some research (Bishop, 2008; Jehangir et al., 2015).

Cultural incongruence between home and school is well-documented for first-generation, low-income, students of color (Lin, 2011; Roberts & Rosenwald, 2001). However, the cultural incongruence did not seem as much the case for these students, perhaps since most of the students lived at home, maintaining family responsibilities while attending school. Additionally, as a Hispanic-serving institution with large percentages of first-generation, low-income, students of color, the Research University may be more attentive to the cultural norms of these underrepresented students, than the majority of higher education institutions across the country.

In general, this study's findings did not align with many of the deficits in the literature, such as less social capital (Ward, 2012), less college engagement (Pascarella et al., 2004), less sense of belonging (Ward, 2012), and lack of a support network (Lin, 2011). Most importantly, the students in this study illustrated a strong sense of self-belief, rather than the lower levels of self-belief reported in some research (Lin, 2011). These results are a testimony to the assets of these first-generation, low-income, students of color combined with the power of having a diverse student population at an institution that supports these students to thrive in college.

In summary, it was reaffirming to hear the pride the students had with their identities and how they saw these identities as assets to their college experience. This is not to say there were no challenges, because the deep pressure to succeed and balance all their responsibilities was readily apparent. Despite the challenges of these underrepresented identities, they also shared their identities were accepted at this institution.

Determine Math Intelligence

Overall, the math placement experiences for students in this study were not positive. For many of the students, the experience created a lot of anxiety. They had a fixed mindset viewing intelligence in math as set in stone, rather than a growth mindset that frames intelligence as a

learning opportunity that evolves (Dweck, 2006). Along with a fixed mindset about the math placement, there was little support to assist with preparing for the exam. Most students in this study did not use the available support resources. Finally, the math placement exam had both positive and negative impacts on students' self-belief, and the placement results did not match the math course that half the students in this study enrolled.

Taking the math placement exam is usually one of the first college assessments for incoming students. It sets a tone at the beginning of their college experience, especially for those working toward a STEM degree. Because this is a high-stake exam taken during a time of big transition when students are preparing to begin college, one can see how this test can be viewed as defining the student's capability to do math with a fixed mindset, rather than perceiving poor results on an exam as a learning opportunity framed within a growth mindset. It was interesting to note, these same students endorsed a growth mindset, once they were enrolled in a math course.

As students were preparing for the exam, there was minimal support offered. The lack of support in the math placement process is further compounded when considering Stephens et al. (2012) research that first-generation students identified with an interdependent culture (i.e., the institution is supporting students for success) rather than an independent culture (i.e., student success is up to the student), which is common of most higher education institutions. The math placement exam is structured so the student is solely responsible for his or her performance, preparing for the exam in a solitary manner. This is a challenging structural issue, even if the university wanted to provide more systematic support for students, since the timing is before students have started college.

Even though this is a high stakes assessment, most students in this study did not prepare for the exam. Some students either cheated on the exam or thought about cheating. These actions could be viewed by advisers and staff as thinking these students are not taking college seriously, or trying to take the easy route, which could be detrimental. What became apparent to me was the students cared deeply about the math placement exam results. Most of the students did not prepare, because they wanted the exam to be an accurate reflection of their abilities, or they assumed they would do well because they were naturally good at math, rather than not being concerned about the math placement process.

It became even more complicated when they were faced with the ethical dilemma of cheating, which I think mainly stemmed from the anxiety they felt and the financial burden to place in a lower level of math, which would require more math courses and additional tuition funds. With this pressure, some of the students did not seem to fully consider with cheating, it could be more difficult to place in a higher-level math and succeed.

Even though all the students in this study were pursuing STEM degrees, they had a broad range of placement in math courses ranging from remedial math to calculus. Mostly dependent on the math placement exam results, students had both positive and negative impacts on their self-belief in math. One of the students, who did well on the placement exam, shared that this experience reinforced that she could do college math. Several of the students, who did not place into college level math, questioned their self-belief in math. If students are viewing this placement exam as one that determines their intelligence in math, not performing well on the exam may impact an internalized belief in a lack of their capabilities before the student even begins college. This finding is reinforced in research at a community college by McDaniel (2012). When students failed the math college placement test, they reported receiving a clear

signal they were not prepared for college. Overall, the math placement process did not promote self-belief with these students in being successful in college math.

In the end, considering the effectiveness of the math placement exam, half of the students in this study enrolled in courses different than their math placement results. It was disappointing that all the students that started in math courses that were lower than the course they placed into were female, suggesting that they may have experienced imposter syndrome of not having self-belief in their math abilities. Based on the placement experiences of this group of students, the math placement exam did not seem worth the time and resources, not to mention the anxiety rather than encouragement it produced as they began their college experience.

These findings also point to the complexity of determining math readiness for success in a math course. Traditionally, institutions of higher education have based these decisions solely on academic preparation, but recent research suggests overall college readiness is based on many factors beyond academic skills, such as self-efficacy and motivation (Arnold, Lu, & Armstrong, 2012). Additionally, it is important to acknowledge the assets diverse, first-year students bring to the learning process that cannot be measured by standardized tests (Higbee, 2004). Perhaps students could reflect on their own psychosocial factors in relation to math readiness. For instance, six institutions involved in the Mathematic Association of America (MAA) National Study of College Calculus research allowed students to self-place in a math course (Hsu & Bressoud, 2015).

Beyond the psychosocial aspects of math readiness, there are ecological considerations of integrated interactions of people, organizations, systems, culture, and time (Arnold et al., 2012). This may seem challenging when applying these broader considerations to the math placement exam, but Arnold et al. suggest direct experience with the institution is more impactful than

indirect experiences when determining college readiness. For instance, several case study sites in the MAA College Calculus research made placement decisions based on conversations between students and university staff members (Hsu & Bressoud, 2015).

Nationally, other impactful math placement strategies found in the MAA Calculus Research project include using on-going data and multiple measures to monitor the effectiveness of the placement exam (Hsu & Bressoud, 2015). One strategy to improve the math placement exam is to use an on-going adaptive assessment that provides an opportunity for students to improve their math placement. Another initiative is to eliminate the math placement exam and utilize existing ACT/SAT scores along with high school math courses and grades, which are thought to be more comprehensive, accurate information to determine placement. It should be noted that there are well documented challenges with the inclusivity of ACT/SAT scores.

An approach to utilize a placement process that allows for on-going efforts to change the placement in a math course is using ALEKS, an adaptive learning and assessment platform. Students are initially placed in a course, but are provided the opportunity to improve their placement by continuing to work in the learning module. This process can be empowering and reinforces a growth mindset that with continued effort to engage with the material, a student can demonstrate competency to move to a higher level math course (Department of Mathematics, n.d.). At the University of Illinois, ALEKS placement had a higher correlation with college math course outcomes than the math ACT score (Ahlgren Reddy & Harper, 2013).

Starting in 2018, the California State University system will eliminate math placement exams and use ACT/SAT scores, and high school math courses and grades (Smith, 2017, June 13). The rationale for this change is that research indicates high school grade point average is a better indicator of readiness to take and succeed in college math courses (Vandal, 2017,

November 22). This triangulation of several data points, especially high school grades based on a series of evaluations throughout a semester, is more effective than solely relying on a placement exam, which is one data point at a single point in time. This approach shifts the paradigm of relying on students to demonstrate their readiness to take a math course immediately before they start college, to one based both on assessment (ACT/SAT), as well as their past on-going experiences with math. California's changes align with a national effort by College Complete America to improve college completion rates, by focusing on how math placement can be improved. Based on findings from this study and the existence of alternative math placement possibilities, I strongly recommend higher education institutions restructure the traditional ineffective placement structures.

Although the group of students in this research cannot be compared more broadly, we know underrepresented students are performing at lower levels on math placement exams than the majority students. For instance, at Colorado State University (2016) after controlling for prior academic preparation, first-generation, Pell Grant recipients, students of color were significantly less likely to place in college algebra compared to their peers, suggesting there may be other issues influencing math placement. Consequently, it is imperative we critically re-evaluate the math placement process to focus on equity, encourage a growth mindset, and provide mechanisms to support student success in math within an asset framework.

Transform to Engaged Math Learners

Students illustrated areas that positively influenced their beliefs in being successful in math that combined in a theme of being engaged math learners. This transformation of engaged learning centered around value for practice and devoting time, gain mastery with mathematical concepts, work with other students, and understand the importance of seeking help.

Value of Practice and Effort

The students definitely saw the value of practice and devoting time as part of their math course, even though this was not evident in the math placement process. This value is a testimony of these students having a growth mindset or being engaged in the learning process to become more competent in math (Dweck, 2006). Perhaps it is easier to have this growth mindset framework in a classroom setting with support from the instructor and other students, rather than the placement exam process.

Although as researchers and practitioners, we think practicing and effort are obvious for success in math, the students' perspectives suggest it is a process for college students to realize and appreciate the importance and connection of effort to success. Consequently, as higher education educators, we need to emphasize the importance of practicing to incoming students at orientation and at the beginning of math courses, especially for student in STEM. Before classes begin, current college students could also share this message to incoming students which provides vicarious messages as part of Bandura's self-efficacy theory (1977) encouraging student success in math. Faculty can reinforce the importance of practicing by assigning graded practice problems, especially at the beginning of the semester. Graded practice problems were an overarching preference with students in this study, even if it was for a small percent of the grade.

Along with providing greater attention about sharing the importance of practice and effort, university messaging could also be more focused about suggestions for academic success in math. Currently, most messaging for academic success during orientation is fairly generic, such as you need to study two hours for every hour you spend in class. Tailoring these messages to specific disciplines, such as the need to practice problems in math compared to thinking about general concepts in history, may be more impactful.

It is also important to note only messages about the importance of effort may not be helpful for underrepresented students. Wood (2017) suggests more comprehensive messaging of both effort and ability are needed, especially for Black men who often have not received messages they have the ability to succeed. This point aligns with the next category of gaining mastery along with spending time and effort.

Gain Mastery with Mathematical Concepts

Students in this study shared examples of gaining mastery, a component of Bandura (2001) self-efficacy, or belief in attaining one goals. Mastery experiences are an individual's past successes or failures. Successful experiences tend to enhance one's self-efficacy. Even a small performance success that influences an individual's outlook on his/her ability to succeed can enable a person to go beyond current performance levels to high levels of achievement.

Student examples for gaining mastery include know concepts in their heads and able to write it on paper, solve a problem, understand a concept, practice on their own, teach concepts to other students, know they would do well on the first exam, and do well on the first exam. I thought it was interesting that many of these examples are small experiences, such as solving a problem or understanding a concept that Bandura talks about making a difference in self-efficacy. One way to achieve this goal is to have a low stakes exam early in the semester, so students can experience success or failure to gain mastery that can be reinforced or readjusted before the first big exam. For instance, weekly practice exams lowered failure rates in an introductory biology course, compared with similar courses with a few high-risk assessments (Freeman, Haak, & Wenderoth, 2011).

Another finding to note is students teaching concepts to other students to gain mastery. This opportunity exemplifies vicarious experiences, also part of Bandura's theory, by seeing

students modeling their success to raise other students' self-efficacy beliefs. Providing opportunities in class for students to work in groups and teach each other is a component of active group learning, a best practice in undergraduate education (Chickering & Gamson, 1987). Reinforcing both the value of practice and effort, and providing many, varied opportunities to gain mastery experiences are important for all students; but may be especially impactful for underrepresented STEM students in promoting their self-belief for success in math.

Work with Other Students

Along with valuing practice and effort, and gaining mastery experiences, another component that impacted students' transformation as engaged learners was working with other students. One of the most powerful themes of this study was the importance of community, as a core component of success in math. This theme aligns with research that found peers who offer encouragement help first-generation college students transition to college (Coffman, 2011) is beneficial during their college experience for first-generation, low-income students (Jehangir et al., 2015), and impactful for first-generation, low-income, students of color students to obtain a college degree (Lourdes, 2015). Other studies illustrated a lack of peer support was a negative predictor of college adjustment for ethnic first-generation students with lower grade point averages during the first year spring semester (Dennis et al., 2005).

Most students in this study articulated value in working with their peers to motivate them to go to class or finish the homework, and receiving help when they were struggling. These components also demonstrated to the students that they were not the only one experiencing challenges with the course. Studying together also provided an opportunity to learn different approaches to solving problems, as well as a venue to check solutions.

What struck me about these findings is that most educators would support students working together outside of the classroom and agree this is a powerful strategy for student success. Yet, this strategy is often left up to the students who may or may not have friends in a course, who have varying levels of comfort in reaching out to other students to study, or who may or may not value the importance of working with other students. This was very apparent to me when Victoria and Ben did not pass calculus their first semester. Neither one had any connection to other students in this class. Victoria shared she did not connect with other students because it was mostly adult learners taking the night class. It was amazing to see the difference when she took the course again during the day and how excited she was sharing her connections with other students who she had worked with in chemistry, which she called the Dream Team. I think she would have appreciated a connection with other students her first semester, but she didn't feel comfortable reaching out to them. The intentional efforts of students working together in chemistry spilled over into math when she retook the course, which was the case for several students in this study.

Ben did not have connections his first semester and saw no purpose. He viewed college as coming to campus, attending lecture, and then leaving. He also had work requirements that made it difficult to study with others. In both cases, I think if there was some intentional group work in class or required group work outside of class, it would have been helpful for both Victoria and Ben. In working with adult learners, Victoria may have been able to build a connection with students having different life experiences with a similar goal of taking calculus. Ben, as a first-year student, could have been introduced to the possible benefits of working with other students.

Based on the findings, these students believed working together positively impacting self-belief and success. Hence, creating intentional opportunities for students to work with other students in and out of the classroom is recommended. This is strongly recommended in introductory STEM which student success is necessary to continue in science, technology and mathematics majors. This practice would ensure all students receive the opportunity to participate in this important strategy for success and self-efficacy which is an interdependent interaction of both an individual, communities, and organizations (Bandura, 1977).

Recommended possibilities to intentionally reinforce students working with other students are in-class group activities, class rooms with desks and tables that can be re-arranged to promote student interaction, assigned out-of-class group activities, and institutional on-line mechanisms that support creating study groups.

Seek Help

Student perspectives about seeking help evolved to feel more confident about asking for assistance, and transitioned from being an independent learner to becoming more interdependent in seeking assistance. Taking the time and effort to seek assistance is a testimony of transforming into a more engaged learner. Although this transition from independence to interdependence is a theme for many student development theories, such as Baxter Magolda's (2009) theme of self-authorship, this may be more complex for underrepresented students. For instance, Orbe (2008) shares for many first-generation students attending college symbolizes independence in a way more prominent, since they have navigated the process to enroll in college more independently than continuing generation students. This independence can be juxtaposed against the need to connect with others, which was definitely the experience of Sofia, who strongly valued her independence, but gained an appreciation of her participation in a

learning community. Emphasizing that seeking help is another strategy of engaged learning could be messaged by upper-class first-generation, low-income, students of color during orientation, sharing how they evolved from independent to interdependent learners.

When reflecting on these findings, it was impactful to see how engaged these students were in their learning. These findings were hopeful when reviewing some of conflicting literature with lower levels of academic engagement that continuing generation students defined by course-related peer interaction and study time (Pascarella et al., 2004), and lower levels of support from peers for first-generation, low-income, students of color compared to continuing-generation, higher-income, White students (Lin, 2011). Although this study's findings cannot be generalized to the broader first-generation, low-income, students of color population and there was no comparison with continuing-generation, higher-income, White students, this study's students valued the importance of engaged learning and working with other students to enhance the learning process.

Thrive in an Inclusive Classroom

Integral to students transforming into more engaged learners, students highlighted inclusive classroom pedagogies that positively influenced their self-belief for success in math. These pedagogies included active group learning, diverse experiences and approaches, and a community of care. These components provide only a slice of inclusive pedagogies that focus more on the culture of the classroom and interactions with the instructor and students, rather than delivery of specific math curricular concepts.

Active Group Learning

The first highlight of inclusive pedagogies that students conveyed as important to their self-belief was active group learning. This active group approach has been well researched for a

decade in high schools to enhance student learning (Boaler, 1998). These findings also align with research on inclusive teaching in STEM that encourages group work and active learning to promote student learning and success. In a meta-analysis of 225 studies, Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, & Wenderoth (2014), found that exams scores averaged 6% higher with active learning compared to lecture delivery in STEM courses. Focusing on mathematics, MAA College Calculus research identified active learning as one strategy to promote success in calculus (Larsen, Glover, & Melhuish, 2015).

The majority of the student participants in this study preferred a course format that included group activities in class, with little preference for lecture as the primary mode of instruction. Of all the findings from this study, the consensus of agreement around the importance of active group learning was one of the strongest. Although we know the benefits of active group learning for all students, it may be even more impactful for first-generation, low-income, students of color who value interdependence and community.

What was somewhat shocking at Research University that may occur across the country was the vast variation with some math classes using exemplary work in active group learning, and other classes where active learning was completely absent. When students in the study had experienced a class with active learning and then enrolled in another course that was primarily lecture, there was a very strong reaction that lecture delivery was not working for them. There was also a pattern that more active learning was occurring in pre-calculus courses compared to calculus courses. Additionally, the active learning in chemistry classes at Research University was often mentioned as a component students also appreciated.

A vast range of courses integrating or not integrating active group learning may represent that higher education institutions are in transition, moving toward incorporating active group

learning in the classroom. If higher education wants to further incorporate active group learning as a common practice in classrooms, the next challenge is institutional implementation. From a faculty perspective, although faculty may have the desire to implement active learning, there may be concerns about having less time to share specific content, concern about this approach in large classes, a hesitation to try new models, or little incentive to evolve to a more active learning approach. Implementing active learning as a consistent approach from a departmental perspective requires a balance of acknowledging the autonomy of faculty members, especially tenure track, along with encouraging departmental coordination to provide more consistent innovative instruction to benefit students.

On a university level, the institutional goals of student learning and success need to be balanced with acknowledging disciplinary expertise. The challenges of systemic change cannot be underestimated. Especially since, according to Kezar and Carducci (2009), higher education is a loosely coupled organization often uncoordinated and differentiated across the university. Despite these massive challenges, continued reinforcement of active group learning as a standard practice in pre-calculus and calculus courses is strongly recommended.

Diverse Experiences and Approaches

Along with active group learning, another example of inclusive pedagogy that students highlighted was the instructor responding to various student experiences in the class, and teaching different ways to approach a problem. Diverse student experiences are reinforced in the literature. Saunders and Kardia (2011) share part of creating inclusive classrooms is incorporating respect for multiple perspectives and varied experiences for a range of students.

One example of this acknowledgement of various learning experiences is students' valuing when instructors took time to explain concepts that the students were struggling.

Additionally, sharing alternative methods to solve a math problem. Faculty, learning assistants, and other students often shared alternative methods to solving problems in this study. This broadened way of sharing diverse paths to solve a problem was reinforced by Sonnert and Sadler (2015), who found this approach had a positive impact on students' confidence, enjoyment, and persistence in mathematics. Additionally, Miller (2005) shares that it is common for underrepresented students to use their own methods for problem-solving, so instructors who insist on one route to reach an answer can discourage students from reaching their potential.

Both of these examples for diverse experiences and approaches focus on the student learning process as part of sharing curricular content and knowledge. Although both student learning and knowledge distribution are essential components of education, it is important for faculty to constantly consider the balance of sharing knowledge and student learning to ensure student success. On a broader level, critical analysis of course content must be evaluated as fitting into entire major programs of study to determine which mathematical concepts are essential and which are not as essential. If there were essential and recommended levels of curriculum content, it would allow for more flexibility in taking extra time when needed in essential areas that students are struggling.

Utilizing learning assistants and encouraging students to teach students as peers are optimal structures to support diverse experiences and provide alternative ways of problem-solving. Although it is impactful for faculty to share these alternative approaches, using other students, whether it be a mentor role or students in class, will inherently provide these more inclusive experiences and approaches. Consequently, using students as a strategy to impact student success is recommended.

Community of Care

Inclusive classrooms are classrooms where instructors and students work together to create and sustain an environment where everyone feels safe, supported, and encouraged to express her or his views and concerns (Saunders & Kardia, 2011). Faculty creating a community of care was mentioned throughout the interviews as highly important for most students to feel they belonged in the math class and believed they would be successful. This perspective was reinforced by Johnson and Hanson's (2015) research illustrating faculty caring about students by listening to questions, asking questions to gauge understanding, inviting questions to make students feel comfortable about learning, and sharing beliefs that students are capable of working through difficulties.

Many of these examples demonstrate the importance of faculty-student interactions. Although strong faculty interactions reinforce well-established, high quality teaching practices, it is an important reminder to keep these qualities at the forefront, especially in college courses. Ensuring faculty interactions with students may be even more imperative for first-generation, low-income, students of color. This is reinforced by Lohfink and Paulsen's (2005) work that found that first-generation student participants who had higher levels of academic engagement focused on faculty-student interactions, persisted in college at higher rates than students with lower levels of academic engagement. Research by Olive (2009) also found many of the challenges first-generation, Hispanic students faced in college were countered by interactions with faculty, which enhanced intellectual curiosity, academic potential, and increased autonomy. Additionally, the importance of cultural support has been found with low-income students, revealing what mattered most was the intervention of at least one adult mentor at crucial times in their lives, such as in college (Levine & Nidiffer, 1996).

Creating a community of care is a concept most would agree, but wide spread implementation is challenging. Many faculty are already doing an excellent job of creating a community of care, witnessed at Research University during some of the classroom observations. On the other hand, some faculty may have varied perspectives on the importance of valuing a community of care in their course, not having the skill set to promote community, concerns this will interfere with focusing on math content, or are challenged with class size. Institutional priority including intentional resources and support, to provide both encouragement and empowerment for faculty to integrate a community of care into their classes, is imperative to enhance these efforts. This is especially important in STEM areas which often have high fail rates.

Additionally, institutions could do more to intentionally promote students by creating a community with other students. Many institutions encourage these peer connections as part of the institution, in residence halls, and involvement in co-curricular activities. However, more emphasis could be placed on similar messaging and connections for academic success, especially for first-year students. For instance, more intentional support could be provided to create study groups for students who do not have existing student contacts in classes, and sharing testimonies from upper-class students on how they connected with other students in classes could be impactful.

Beyond creating study groups, the importance of students helping other students to be academically successful could encourage going to class together, motivating each other to study, and checking in with a student if he or she was not in class. Since we will never have a situation where all faculty adopt community of care principles, focusing on simple, but impactful,

strategies to enhance students creating a community of care for each other to promote academic success has the potential for widespread positive results.

Active group learning, diverse experiences and approaches, and a community of care all point to inclusive pedagogies that value the importance of a collective approach to education, rather than viewing education as individual students solely being successful or not. These community practices have a positive impact for all students, but may be of particular benefit for first-generation, low-income, students of color.

Support for Success in Math

Building on inclusive pedagogy in the classroom, support structures were highlighted by students' in this study as having a positive impact on their self-belief in being successful in math. The most prominent support structures commonly mentioned were on-going, frequent course feedback, learning assistants, and the Math Lab.

The most important support structure for students' success was accountability and learning that came from graded homework and quizzes. With the demands many of these students were balancing, they really appreciated regular graded assessments throughout the course to ensure their on-going efforts would be successful. The other positive factor of this feedback was students learning what they did and did not know early in the semester. Additionally, this is a mechanism for faculty to make the learning objectives explicit before the exam and help them diagnose problems. The importance of prompt feedback is one of the principles of quality education (Chickering & Gamson, 1987). Although this may be a fairly standard practice, since the majority of institutions in the MAA College Calculus research provided graded homework (Burn & Mesa, 2015), it is important to emphasize the impact and benefits of course feedback.

Along with course feedback, the learning assistant's role is a testimony to the power of using other students to demonstrate how to be successful in math and to encourage student's capability of being successful. Learning assistants illustrate a way to implement vicarious experiences and verbal persuasion in math courses, components of Bandura (1977) self-efficacy theory. Vicarious experiences are students comparing with others, similar or slightly above the individual, such as upper level college students serving as learning assistants working with less experienced students. Verbal persuasion is significant to others by providing positive validation in the belief of an individual's capability to succeed. As with vicarious experiences, verbal persuasion is more believable, if it is given from people moderately beyond what the individual(s) can do at the time, which is fitting of learning assistants.

I had the opportunity to observe the learning assistants in the Math Lab and was impressed with how accessible they were to students. They were constantly walking around the room, creating a welcoming environment to engage in dialogue. I also think the central approach of coordinating the Learning Assistance Program with high quality training including a course, on-going dialogue of their experiences through regular meetings, and professional development opportunities made a difference in the positive impact of this program. Utilizing learning assistants is a powerful mechanism, helpful to the students taking the math class, and to the learning assistant students. It is a fairly low-cost initiative to provide support for large groups of students not possible for one faculty member to achieve.

To further support the engagement of learning assistants, the Math Lab required students to spend three hours a week at the lab to complete graded homework. Most students felt extremely positive of the Math Lab, appreciating the step-by-step structure, weekly time

requirement, and the learning assistant student staff. Many of the students in this study suggested a similar lab for their calculus courses.

All of the support structures these students felt positively impacted their self-belief, seem realistic to implement throughout higher education. Although creating tutorial labs and learning assistance programs require effort and resources, the return on investment for these support structures are worth the investment.

Theoretical Discussion

As mentioned previously, the theoretical scaffold for this study is structured within the power of positive psychology and its potential influence on math completion. Theories to inform this framework are stereotype threat (Steele, 1997), which challenges college success, and self-belief (Bandura, 1977; Dweck, 2006), which can potentially mediate challenges and promote academic success.

Stereotype Threat Theory

Stereotype threat theory asserts negative stereotypes of one's performance, based on his or her social group can place individuals at risk of lower performance (Steele, 1997). This threat is well-documented as a barrier to academic achievement, predominately with quantitative studies. Hence, this study's qualitative research adds to the literature. Two aspects of stereotype threat include personal investment and environmental cues of an experience. First, students who are invested or care about school are most influenced by stereotype threat, compared to those who were not as motivated. Second, environmental cues can influence stereotype threat, such as the number of people with similar identities, powerful people with similar identities, and the inclusiveness of an institution to embrace various identities (Steele, 2010).

In this study, I learned all the students deeply cared about their college experience, perhaps since they had a great appreciation for the opportunity to gain higher education. Thus, they may be more sensitive to stereotype threat. The students often identified the negative stereotypes of their social group with terminology of being ‘other’ or ‘underclass’, or a negative statistic. They shared specific incidents of biased treatment, especially as a woman in STEM. Although these students as a part of traditionally stereotyped groups faced challenges, the institutional environment at Research University mitigated much of the potential negative influences on stereotype threat with the large numbers of students with similar identities, large percentages of faculty of color, and the presence of inclusiveness integrated throughout the university.

Self-belief Theories

Self-belief is founded in Bandura’s theory of self-efficacy and Dweck’s theory of a growth mindset. Self-efficacy is a social cognitive theory, based on “people’s beliefs in one’s capacity to organize and execute the course of action required to produce given attainments” (Bandura, 1977, p. 6). The self-efficacy framework is made up of four sources of efficacy including mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. Illustrations of self-efficacy were very evident in this research with mastery experiences, including both students’ successes and failures, vicarious experiences of learning from peers, and verbal persuasions focused on positive validation from faculty. There were no findings related to physiological and affective states of how stress impacted motivation or was a deterrent.

Growth mindset, another aspect of self-belief, is a belief that one may improve through engagement with the learning process (Dweck, 2006). This differs from a fixed mindset, where

one's qualities are perceived set in stone, success is about being more gifted than others, and effort is not a high value. The results from this study were interesting, since, in general, the students viewed the math placement exam with a fixed mindset and math courses with a growth mindset, suggesting that mindset may be situational. This finding reinforces the limitation of a growth mindset as a binary approach with no emphasis on the social cultural aspects of an experience which may impact one's mindset. Additionally, Wood's (2017) critique of growth mindset and students of color, is racism may inhibit effort and a more comprehensive framework of both effort and ability is needed. Prominent findings in this study center on the importance of mastery experiences and gaining positive validation from faculty, reinforcing that a more comprehensive framework may have more potential to empower success with underrepresented students.

I recommend expanding Bandura's self-efficacy theoretical model to include the growth mindset of Dweck's theory. The more comprehensive psychological, social cultural, and environmental approach in Bandura's theory would address the limitations of not including the situational aspects of a growth mindset in Dweck's theory. Additionally the value of learning through effort in the growth mindset theory would supplement the components of self-efficacy including mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. The growth mindset could be incorporated as a part of gaining mastery experiences which currently is not addressed. Combining situational aspects of self-efficacy in a variety of sources from Bandura's theory and the learning through effort aspect of Dweck's theory together, would provide one broader more comprehensive framework. More scholarly inquiry would be needed to further explore this recommendation along with analysis to

determine if this framework responds to the well-established stereotype threat for underrepresented students, and addresses our diverse college student population.

Incorporate a Community Approach to Learning Math

One of the main insights for me from this research study was the powerful impact of students working together to support each other and how much this impacted their self-belief. Consequently, we need to empower students more intentionally. Their role is to help each other become successful in math. Additionally, this study highlights concrete examples for faculty and institutions to support students' evolving to become more engaged math learners, implement inclusive pedagogy, and provide support structures that have the potential to positively impact first-generation, low-income, students of colors' self-belief and hopeful success in pre-calculus/calculus courses.

A Community Approach to Learning math illustrates the findings of this research holistically in a way that higher education can comprehensively move forward to improve success in pre-calculus/calculus courses by integrating engaged learning, inclusive pedagogies, and support structures together as one cohesive framework to learning. This Community Approach to Learning would encourage faculty to place more emphasis on teaching how to become an engaged learner in the classroom, fully incorporate students working with other students both in and out of the classroom, and emphasize the role of both faculty and students working together to create a community of care in the classroom.

The Community Approach to Learning is also based in promoting self-belief with students being successful in math. Engaged learning with practice to gain mastery combines Bandura's self-efficacy and Dweck's growth mindset that students need to put in the effort and have successful experiences. Students working with other students reinforce the vicarious

experiences of students seeing other students model their successes as part of Bandura’s self-efficacy. More specifically, vicarious experiences are best accomplished when comparing with others, who are similar or slightly above the individual with similar identities, which aligns with the learning assistant role. Additionally, part of the community of care includes verbal expressions which are part of self-efficacy in providing positive validation in the belief of an individual’s capability to succeed. Within the Community Approach to Learning these messages are given by faculty to students, learning assistants to students, and between students themselves. All of these components of self-belief as part of the Community Approach to Learning illustrated in Figure 2, have the power to positively impact success in math.

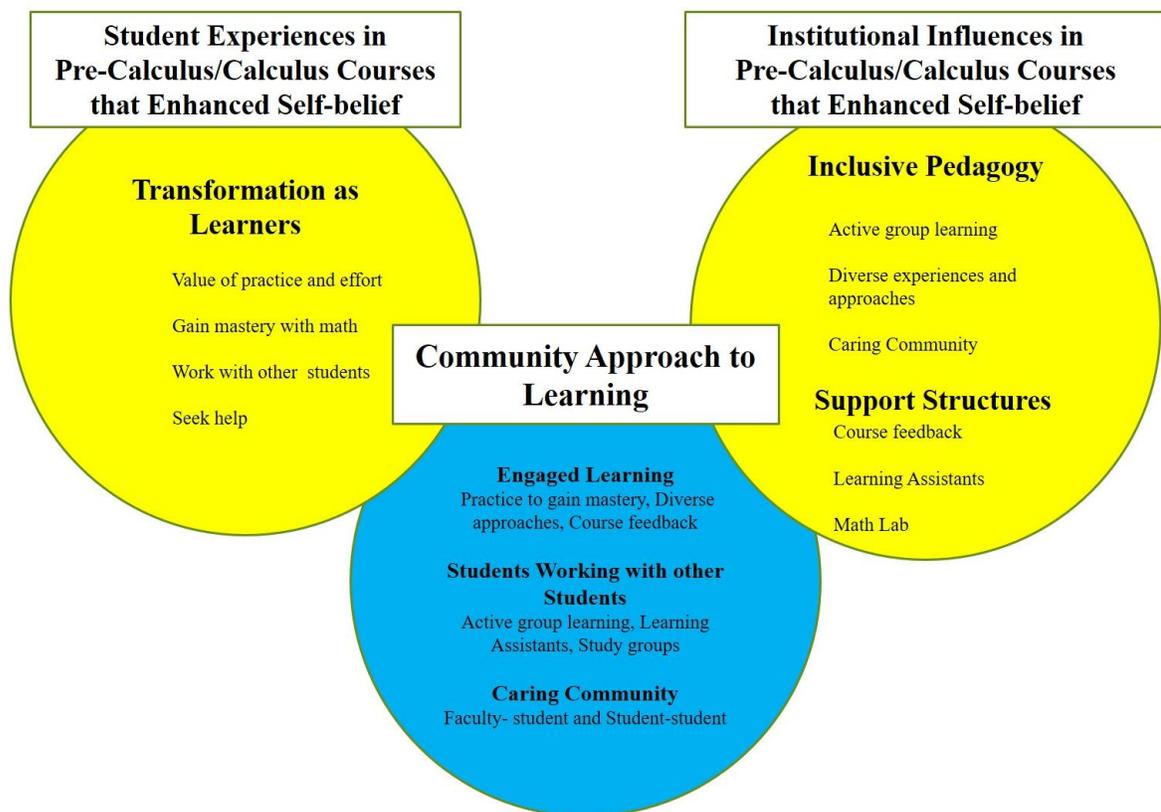


Figure 2. Community Approach to Learning

The intentional emphasis on engaged learning would be particularly beneficial to first-generation, low-income, students of color as a method to increase their cultural capital for

success in math by providing explicit strategies for academic success from faculty and upper-class students. Additionally, as we know from the literature, these students operate best in a culture that fosters interdependence. So, students learning from other students set the stage for success. Finally, empowering students purposefully to help each other become successful in math can have more far reaching impact than relying totally on faculty student interactions.

For faculty within the Community Approach to Learning, part of creating inclusive classrooms is supporting engaged learning. This approach would include time at the beginning of each semester/quarter to discuss general strategies for being successful in math, such as the value of practicing and asking for help. These messages must be tailored to the discipline of mathematics, and could be a combination of messaging from faculty and students who have completed the course. Other faculty messages to support an inclusive community would be expressing care about student learning and success, belief that all the students have the potential to be successful, and importance of faculty and students working together to create this community for success.

Utilizing other student mentors, such as learning assistants, is an excellent way to reinforce this community approach between the instructor and the students, and to provide leadership in modeling the value of students working with other students. Empowering students to be instrumental in cultivating this supportive culture can go beyond active group learning and teaching each other; by allowing students in small groups to support each other's academic success.

This community approach could lay the groundwork to address situations when students are experiencing situations that do not seem inclusive to them in the classroom. I know this is a challenge, since there is a power differential between the instructor and student, but perhaps this

could be partially achieved with mid-term evaluations that inquire about an inclusive classroom culture. Therefore, adjustments could be made during the semester. Overall, creating a learning community culture expands the traditional role of the faculty being mostly responsible for the classroom culture to include students both as peers and mentors, who together can have a broader, more positive impact.

Implications for Practice

This study highlights concrete examples for faculty, math departments, and higher education institutions to implement supporting students' evolution to become more engaged math learners, administering inclusive pedagogy, and providing support structures that have the potential to positively impact first-generation, low-income, students of colors' self-belief and hopeful success in pre-calculus/calculus courses. First of all, in developing the educational pipeline between high school and college, higher education institutions need to learn from K-12 which have researched the positive impact of inclusive pedagogy for several decades, and have instituted active group learning as a common practice. Stronger alliances instead of current barriers need to be built between K-12 and higher education to reinforce these impactful practices.

Additionally, K-12 teachers, administrators, and policy-makers must continue to focus on math preparation. In this study, many of the students had a negative experience in high school math stemming from getting lost in AP courses, regretting they did not take sufficient math or AP math courses (e.g., half of the students did not take a math course in their senior year), or did not apply themselves as much in high school as they wished, once they were in college. State policies that require four years of high school math to attend college, along with college student

testimonials sharing the importance of math with high school students, are a couple of strategies that could begin to strengthen high school math experiences.

Implications for Faculty

Specific strategies that became apparent in this research focus on ways to promote self-belief in math including engaged learning, students working with other students, and a community of care. Comprehensively, these results illuminate student voices to inform teaching approaches that strengthen discipline based pedagogies. As mentioned earlier Ramsden (2003) shares teaching and learning are linked, and faculty must listen and learn from their students to adapt their teaching practices.

Incorporating engaged learning includes practice to gain mastery, course feedback, and diverse approaches. Students want practice problems in class. It is imperative to allow time in class for students to apply the concepts within the classroom environment to learn these concepts. Students also want frequent on-going feedback with graded practice problems even if it is for a very small part of the grade. Providing a low stakes exam early in the semester also gives feedback so students can experience success or failure in gaining mastery, reinforced or readjusted before the first large exam. Diverse approaches include taking more time to explain concepts when students are struggling, continually balancing course content with student learning. Another example of diverse approaches is sharing different ways to solve a problem, and encouraging learning assistants and students to also share alternative approaches.

One of the main findings of this research is the power of students working with other students. Active group learning allows students to teach each other, understand what they know and what they still need to work on, enforce a community of supporting each other in being successful in the course, and normalize and empower students especially when they struggle.

Additionally intentionally assigned study groups outside of class, perhaps with learning assistants can further reinforce these student to student connections and support for each other.

Finally a community of care starts at the beginning of the semester, when faculty share explicit strategies to become successful in math such as the value of practice and asking for help, express their care about student learning and success, and most importantly belief that all students have the potential for success. This continues throughout the class when faculty show up to class with a positive outlook, relate to students on a personal level, know student names, and share disappointment when the class does not perform well. Knowing that it is a challenge in large classes to have these personal connections, other strategies such as using name cards to identify students by their names in class can achieve the same goal.

Finally, students emphasized that the way faculty members answer questions in class and during office hours demonstrate their dedication to student success, and is very impactful to their self-belief in being successful. Another suggestion would be to have mid-semester feedback to gauge how students are experiencing the Community Approach to Learning, making readjustments as appropriate. This three pronged approach of embracing engaged learning, providing opportunities for students to work with students, and creating a community of care can be instrumental in enhancing the self-belief of students to be successful in math.

Implications for Math Departments

It is strongly recommended that Math Departments drastically revamp traditional ineffective math placement structures, which in this study created student anxiety, promoted a fixed mindset, and was ineffective at placing students in the appropriate course. These initial processes at the beginning of students' college experience are doing the opposite of higher education's desire to enhance math success especially with underrepresented STEM students. If

we want to promote empowering students to be successful in math, more analysis of alternative approaches that are currently being implemented is imperative to develop new processes.

In hiring new faculty, Math Departments need to hire diverse faculty members that embrace a student learning and success philosophy along with teaching competency in mathematics, and that practice or are willing to learn inclusive pedagogies. The Department Head also needs to build strong alliances with institutional supports such as STEM Institutes and Teaching and Learning Centers, continuing to acknowledge expertise in the mathematics discipline while encouraging enhanced teaching approaches.

It is always a challenge for faculty to make changes in pedagogy, especially when balancing research and other demands of being a faculty member. Department leadership can encourage incremental improvement focusing on areas that a faculty member is not currently satisfied in his or her course, and utilizing institutional support programs that connect faculty together who are enhancing their instruction. Departmental support for enhancement in inclusive pedagogy can have powerful impacts on students' self-belief.

Implications for Institutions

Institutional philosophies, structures, and resources are essential in moving the bar to increase math completion especially with underrepresented students. Most importantly colleges and universities must embrace and integrate a student learning and success paradigm throughout the institution. This philosophy is evident with a collaborative approach in working with university wide initiatives and departmental efforts, and providing adequate resources to increase math completion.

Institutional strategies include providing both encouragement and empowerment for faculty to integrate a Community Approach to Learning, implementing support structures such as

tutorial labs and learning assistance programs, and intentionally promoting students creating a community with other students for academic success. Specific strategies for faculty could be providing stipends to faculty that are interested in enhancing a community of learning, and institutional support to create faculty learning communities in this process. Additionally it is imperative that institutions provide resources for class sizes that promote implementing a community of learning, including specific strategies that can be incorporated with larger classes, and classrooms that are physically set up to promote student interaction.

Along with providing resources for support structures, institutions need to think of new ways to create student structures for intentional engagement as learners. For instance, requiring students taking math to spend a required amount of time in a math tutorial lab, provides a structure for students to be engaged in the material. Intentional university resources could also assist students in creating study groups which is often an uncomfortable process for many students to initiate, and would provide a deliberate approach to promote student learning.

Finally, institutional structures for sophisticated selection and training programs for learning assistants so faculty are not totally responsible for their oversight, are intentional ways to further enhance engaged student learning. The intentional approach of students creating a community to support each other's academic success could be messaged at orientation programs from current college students. These messages would include the importance of strategies for success in math, such as practicing and spending time and effort, seeking help, and evolving from independent to interdependent learners. There could also be emphasis on looking out for and supporting each other when another student is not coming to class or did not do well on the first exam. This comprehensive approach of faculty, math departments, and higher education

institutions working together to enhance student belief, has the potential to impact higher levels of success in math, especially with underrepresented students.

Limitations and Strengths

Although experiences with math for first-generation, low-income, students of color in this study inform faculty, math departments, and higher education institutions, these results cannot be generalized to all first-generation, low-income, students of color at Research University or other higher education institutions. It was powerful to witness the support these students felt with their traditionally underrepresented identities at an institution with high percentages of this student population. However, it is important that the institutions' demographics remain at the forefront in reflecting on these findings. These experiences may be different on campuses with predominately White, higher income, continuing-generation students. This was very apparent to me when comparing the first-generation, low-income student experiences in the pilot study, who did not feel as embraced by their institution that had lower percentages of first-generation, low-income, students (DiGregorio & Ellis, 2018).

Strengths of this study include researching students at various stages in math (pre-calculus and calculus courses) and college experiences (first-year through junior year), all studying STEM majors, and students who were and were not involved in support programs for underrepresented students. Most of the literature focuses on first-year, first-generation students that are involved in support programs. Additionally, being part of the Progress Through Calculus research project provided institutional context to these findings with math course observations, faculty and staff interviews, and information from a local coordinator. This connection allowed access to institutional data and resources that would have been challenging to accomplish on my own, since I had no direct connection with Research University. Finally,

being part of a research team of math educators provided a broadened perspective to my higher education background, and provided a group of researchers who strengthened the depth of the research findings.

Recommendations for Future Study

Repeating this same study at other research institutions as part of the Progress Through Calculus research project, especially at institutions with lower percentages of first-generation, low-income, students of color, a more common demographic at many institutions across the country, will provide cross institutional results and additional insights. Additionally, more intentional focus on the experiences of STEM students would be beneficial as higher education institutions are working toward higher STEM degrees especially with underrepresented students. Although this study illustrates some promising results to identify factors that promoted student self-belief in math at one institution, more investigations should continue to explore ways to create an environment that promotes self-belief in math to develop the talent of first-generation, low-income, students of color for success in math, empower their collegiate success, and increase the graduation rates of these students.

Personal Reflections

As a first-generation, middle-income, Caucasian researcher, and higher education administrator, I have experience navigating the college experience as the first in my family to attend a four-year institution. As an administrator, I have the opportunity to oversee many programs that support first-generation, low-income, students of color. This research allowed me the opportunity to dive deeper into learning about the experiences of eight students, and to gain a more in-depth understanding and appreciation of the complexities they navigate in college, which were more complex than what I experienced as a college student.

I was reminded that first-generation status permeates every experience, when one of the student participants asked me what he should wear to our interview. It had never dawned on me that providing more context of this ‘interview’ would have been helpful. I also had one interview late on a Saturday night, which was a testimony to all the time demands of this student. What was surprising is he did not mind interviewing on a weekend evening, which was a reaction that I think would have been different from more privileged students.

It was empowering to implement my research at such a diverse institution where these students felt accepted and to witness their deep appreciation of being in college and valuing learning, acknowledging that many in their family did not have this opportunity. It was a testimony to the power of having large numbers of diverse student identities to create a more inclusive environment.

Although the students received money for participating in this research project, I sensed they were participating not only for the remuneration. They were curious, appreciated that I wanted to hear their perspectives, and they liked being part of an effort to improve experiences for other students.

I also gained more appreciation for students who are unable to attend classes or prepare for exams, who may be responding this way even though they care deeply about their college experience. For instance, one student participant did not initially respond to my outreach for the second interview, and after many attempts two interview times were scheduled but he did not follow through. We finally connected and I realized that his resistance to this interview was about the deep shame that he was experiencing from failing calculus, rather than not being responsible. It made an impression that we need to continually reach out to these students, rather than thinking their college experience is their sole responsibility without institutional support.

Along with immense learning from the students, I learned so much from the Project Through Calculus researchers. I felt very fortunate to be part of a team with national known faculty devoted to student success in mathematics. To witness the intentional thorough analysis of selecting institutions to study, to participate in the comprehensive research effort with multiple qualitative and quantitative data sources spanning over two years, and to see the amazing potential for this national research to have a big impact on math experiences, was extremely impactful.

Summary

The results from this research add to the paradigm of sharing assets of first-generation, low-income, students of color on our college campuses rather than viewing these students within a deficit framework. This qualitative research bridges current literature that mostly focuses on the experiences of underrepresented students in college or studies best practices in mathematics education, with knowledge about underrepresented student experiences in math.

Hopefully, this study reinforces the need for higher education institutions to change the traditional math placement practices, incorporate more intentional effort on engaged learning, encourage more consistent implementation of inclusive pedagogies in math courses, and provide structured support mechanisms by including labs and learning assistants. These initiatives implemented within a Community Approach to Learning have the potential to increase self-belief and success for students in mathematics, which can also impact college graduation rates, especially for underrepresented students.

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APPENDIX A

Summary of Critical Research Studies

Study	Purpose	Epistemological Frame & Research Design	Sample & Data Collection	Data Analysis Strategies & Reliability/Validity	Findings
Alessandria, K. P., Nelson, E. S. (2005). Identity development and self-esteem of first-generation American college students. <i>Journal of College Student Development</i> , 46(1), 3-12.	Investigate and describe self-esteem and identity of first-generation and continuing-generation students.	Post-Positivist Quantitative: Difference	First-generation- at least one parent was not born in the US, 175 students at a mid-sized public university, completion of identity and self-esteem instruments.	Erwin Identity Scale-Sample Subscale Reliability: Confidence- .87 Physical Presentation Comfort- .82 Clinical Measurements Package Index of Self Esteem: Sample Reliability .95, Research Sample was representative of the entire college population with sex, religion and race with slight differences in ethnicity (less than 10% difference).	First-generation students had significantly higher levels of self-esteem than non-first-generation students $F(3.144) = 7.36, p < .001$ regardless of ethnicity. First-generation students didn't have significant higher levels of identity development than non-first-generation students.
Aspelmeier, J. E., Love, M. M., McGill, L. A., Elliott, A. N., & Pierce, T. W. (2012). Self-esteem, locus of control, college adjustment, and GPA among first- and continuing- generation students: A moderator	Comparison of generational status and self-esteem, locus of control, college adjustment and GPA.	Post-Positivist Quantitative: Difference and Prediction	322 undergraduate first-generation students (parents with no associates or bachelors) enrolled in an introductory psychology course. Online measures of self-esteem, locus of control, academic	Multidimensional-Multi-attribution Causality Scale - achievement and social domains and locus of control- alphas between .50 and .88 Rosenberg Self Esteem Scale- alphas between .64 and .91	No significance with generational status and self-esteem, college adjustment or GPA, marginal significance for three of the eight locus of control scales. First-generation may benefit more than continuing-generation

of generational status.
Research in Higher Education, 53, 755-781.

adjustments, and self-reported GPA.

Student Adaptation to College Questionnaire- alphas between .85 to .89.

from an internal locus of control and suffer more consequences than continuing-generation from having an external locus of control (could be based on stereotype threat). Self-esteem was more predictive of college adjustment for first-generation than continuing-generation.

Benson, R., Hewitt, L., Heagney, M., Devos, A., & Crosling, G. (2010). Diverse pathways into higher education: Using students' stories to identify transformative experiences. *Australian Journal of Adult Learning*, 50(1), 26-53.

Provide insights into how diverse students succeed in college with the focus on student stories before enrolling in college.

Critical Qualitative: Narrative

Fourteen students entering the Bachelor of Social Work degree program at Monash University in Australia, with diverse backgrounds including first to attend college, low social economic levels, family difficulties, and migrant backgrounds. Longitudinal interviews before, during and after college.

Students identified themselves as nontraditional with diverse paths to higher education. Discourse and content analysis was used to identify major themes of participant interviews. Perspective transformation informed the conclusions of the study. Prolonged engagement with three interviews before, during and after college and member checking with interview transcriptions verified by interviewees.

Most participants had support from their families, positive school experiences, and some support of role models; but had limited guidance or experienced family issues that adversely impacted their education. Positive self-concept was mixed but personal characteristics allowed them to overcome adverse circumstances. Eight participants had transformative experiences either through a disorienting event such as a health crisis, or by gradually changing self-concept. The remaining participants developed a mindset early on that

<p>Bui, K. V. T. (2002). First-generation college students at a four-year university: background characteristics, reasons for pursuing higher education, and first year experiences. <i>College Student Journal</i>, 36(1), 3.</p>	<p>Background characteristics, reasons for pursuing higher education, and first year experiences of first-generation college students.</p>	<p>Post-Positivist-Quantitative: Difference and Prediction</p>	<p>Sample of 75 continuing-generation students enrolled in a general psychology course, and 64 first-generation students participating in a program leading to undergraduate success at the University of California. Questionnaire was utilized.</p>	<p>Reliability and validity was not mentioned in the study.</p>	<p>didn't require a change in perspective to pursue higher education.</p> <p>Reasons for attending college differed between first-generation and continuing-generation $F(32,370) = 2.52, p < .001$. With higher importance for first-generation students to gain respect/status, bring honor to their family, and help family financially. First-year experiences differed for first-generation and continuing-generation $F(32,390) = 2.67, p < .001$ with first-generation students feeling less prepared and worried more about financial aid than continuing-generation students.</p>
<p>Dennis, J. M., Phinney, J. S., Chuateco, L. I. (2005). The role of motivation, parental support, and peer support in the academic success of ethnic minority first-generation college students. <i>Journal of College Student</i></p>	<p>The role of motivation, parental support, and peer support in the academic success of ethnic minority first-generation college students.</p>	<p>Post-Positivist-Quantitative: Difference and Prediction</p>	<p>Longitudinal study (fall and spring of sophomore year) of 100 ethnic minority first-gen students urban commuter university. Simultaneous regression for each of the outcome variables.</p>	<p>Correlation among predictor variables and college outcomes alpha .05. Survey about college attitudes in required first-year course- Survey was modified with focus groups and new measure developed. Follow-up survey in</p>	<p>Personal/career related motivational to attend college (and commitment to college) was a positive predictor and lack of peer support was a negative predictor of college adjustment in fall and lower GPA in spring. Peer support was a</p>

Development, 46(3),
223-236.

Elliott, D. C. (2014).
Trailblazing: Exploring
First-Generation
College Students' Self-
Efficacy Beliefs and
Academic Adjustment
*Journal of The First-
Year Experience &
Students in Transition*,
26(2), 29-49.

This study explored the
relationship between
academic self-efficacy.
beliefs and the
academic adjustment of
first-generation and
non-first-generation
students.

Post-Positivist
Quantitative:
Difference

2,358 students at 25
private institutions in
14 states with (46%)
first-generation. The
Freshman Survey (TFS)
and Your First College
Year (YFCY) were
used for demographic
information, assessing
academic self-efficacy
by students'
perceptions
and beliefs about their
academic ability before
college and after the
first year. Academic
adjustment was
assessed with self-
reported GPA and
perceptions of academic
adjustment.

this second year-
Student Adaptation to
College Questionnaire
alpha .83
Motivation- Student
Motivations for
Attending University
alpha .77
Social Support-
questions based on
provider support model
and focus groups
College commitment-
developed from focus
groups alpha .81.

Self-efficacy measures
on a 5 point Likert
Scale with Cronbach's
alpha .75 and Academic
Adjustment measures
on a 3 point Likert
Scale with Cronbach's
alpha .75. Hierarchical
linear regression was
used to understand the
relationship between
academic self-efficacy
and academic
adjustment.

stronger predictor than
family support. Family
expectation and support
was unrelated to the
outcome.

Positive increases in
academic self-efficacy
perceptions over the
first year were
associated with higher
GPAs. However, as
academic self-efficacy
beliefs increased, the
rise in GPA for non-
first gen students was
more pronounced.
However, even modest
increases in efficacy
perceptions over the
first year were
associated with
substantially higher
grades for first- gen
students. No significant
difference between
first-gen and non-first
gen students in their
adjustment perceptions.
Considering the

<p>Garrison, N. J. Gardener, D. S. (2012). <i>Assets first-generation college students bring to the higher education setting</i>. Paper presented at the Association for the Student of Higher Education (ASHE), Las Vegas, NV.</p>	<p>Explored assets that first-generation students bring to open enrollment higher education setting.</p>	<p>Constructivist Qualitative Grounded Theory</p>	<p>Three interviews of female white first-time college, low-income, first-generation students.</p>	<p>Self-identification of first-generation and low socioeconomic status .Triangulation of archival institutional data, qualitative interviews, institutional survey results, and researcher’s reflective journal entries. Clarified researcher bias and did member checking at the end of the interview.</p>	<p>relationship between self-efficacy and academic adjustment, first-gen students whose efficacy perceptions changed considerably over the first year expressed greater academic adjustment than did non-first-gen.</p> <p>Students in the study had the following personal assets- proactively (seeking resources, strategic thinking for effective decisions, self-reliance- independence) goal direction- purpose filled lives, practical realism, flexibility to adapting to changing circumstances, persistence), optimism (positivity, hope, wanted to be self-sufficient, good wage and an interesting job, self-confidence) and reflexivity (know thyself in a variety of ways, insightfulness, compassion, gratitude, balance). The development of the assets was influenced by lived experience and occurred in response to</p>
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<p>Holodick-Reed, J. A. (2013). <i>First-generation college students' persistence at a four-year college: A phenomenological case study</i>. ProQuest Dissertations & Theses Full Text. (3618382)</p>	<p>Describe the experiences of first-generation college students that contribute to their persistence at a four-year institution.</p>	<p>Constructivist Qualitative: Phenomenology</p>	<p>Fifteen first-generation students in third and fourth year- diverse majors in private four year university Questionnaires and semi structured interviews and field notes by researcher during the interview Purposive sampling- identified through a survey did follow-up email. Emergent design for additional participants.</p>	<p>Triangulation with questionnaires, semi-structured interviews, and field notes; clarifying researcher bias, member checking with reviewing transcripts, and using rich thick descriptions.</p>	<p>their underrepresented socio-cultural positioning. What helped college persistence: knowledge preparing for college- (AP courses in high school and Upward Bound), focus on one's future, receipt of financial aid, supportive family members, good friends, caring faculty and staff (emotional support and academic guidance), feeling of comfort on campus, and expectations from parents to attend college.</p>
<p>Jehangir, R. R., Stebleton, M. J., & Deenanath, V. (2015a). <i>An exploration of intersecting identities of first-generation, low-income students</i> Research Reports on College Transitions No. 5. National Resource Center for the First-Year Experience and Students in Transition.</p>	<p>Overall experiences of first-generation, low-income, upper division college students.</p>	<p>Constructivist Qualitative Interpretive Narrative Inquiry</p>	<p>39 junior and senior first-generation low-income students at a predominately white Midwestern research institution recruited from TRiO and a scholar program. One ½ to two hour focus groups</p>	<p>Data collected in form of stories. Focus groups included the social interaction in the construction of narratives. Data themes were developed independently by researchers and then collectively. All researchers coded the data with these themes and then another coder was used for intercoder reliability.</p>	<p>Student's transition balanced simultaneous isolation and being included and the incompatibility of two worlds. College experiences illustrated being able to cross borders, and being interdependent recognizing family responsibilities and making individual choices. The value of staff and peer support was also a central theme.</p>

Lin, M. M. (2011). *Intersections of race, SES, and first-generation college student status in understanding the factors affecting undergraduate academic persistence: a psychosocial cultural approach*; ProQuest Dissertations & Theses Full Text. (UMI 3488638)

Examine the applicability of a culturally relevant model of academic persistence.

Post-positivist Quantitative: Difference and Prediction

530 undergraduates attending a large public predominately white institution. Self-report web-based survey.

Self-Belief: College Self-Efficacy inventory- α -.93 total score, Educational Degree Behaviors Self-Efficacy- confidence to complete academic tasks- α .93, Imposter Phenomenon Scale- α .77 and .82, Student Motivation for Attending University revised- internal consistency coefficients for the subscales range from .70 to -.88., Problem Solving Inventory- α .72-.90 widely used, Social Support: Perceived Social Support Inventory Family and Friends- internal consistency coefficients for the subscales range from .88 α -.89-.95 with first-gen students, College Mentoring Scale- internal consistency coefficients .85-.91, Cultural Dimension: University Environment Scale- internal consistency coefficients .77, α

Results demonstrated that racial/ethnic minority students, low-income students, and first-generation college students indicated they possessed lower economic, social, and cultural capital than their majority peers. Furthermore, undergraduates who possessed higher levels of capital also perceived higher levels of support from all sources examined in this study (i.e., family, friends, and mentors). For instance, lower class students ($M=2.76$, $SD=.54$) indicated a lower perceived congruity between their values at home and the university. First-generation college students ($M=4.03$, $SD=.63$) reported lower confidence in college-related tasks in comparison to non-first-generation college undergraduates ($M=4.31$, $SD=.53$).

<p>Lohfink, M. M., & Paulsen, M. B. (2005). Comparing the determinants of persistence for first-generation and continuing-generation students. <i>Journal of College Student Development, 46</i>(4), 409-428.</p>	<p>Examine and compare the determinants of first to second year persistence for first-generation and continuing generation at 4 year institutions.</p>	<p>Post-positivist Quantitative: Difference and Prediction</p>	<p>National sample (Beginning Postsecondary Student Longitudinal Study-NCES) 1995-1996 first to second year at the same institution. 1167 first-generation students and 3,017 continuing-generation students.</p>	<p>.84, Cultural Congruity Scale internal consistency coefficients .89 alpha .88, Perceived social status: College Capitol Measure- econ, soc and cultural-created as first of its kind, Undergraduate Minority Status Identity Inventory- alpha .60 to .79, Academic Persistence: College Persistence Questionnaire- internal consistency coefficients .70 and .79 limited utilization.</p> <p>Validity: Cluster weights were used along with SAS to correct for potential bias in parameter estimates and to produce unbiased estimated of standard errors for hypothesis testing. Multiple measures of goodness of fit- log-likelihood, Pseudo $R^2 = .2718$ and adjusted Wald test $F(42,289) = 4.60, p < .001$.</p>	<p>Continuing-generation students reported having more college capital than first-generation college students (M= 3.86, SD = .57 and M- 3.20, SD = .52, respectively). However, racial/ethnic minority and first-generation students reported higher perceived motivation in attending college.</p> <p>First-generation student persistence was 76.5%, continuing-generation 82.2%. Variables the contributed to first-generation persistence include growing up in a home where English wasn't the primary language (14.7% more likely to persist) educational aspirations (7% more likely to persist), choosing a college because of the faculty reputation(15.8% more likely to persist), ability to live at home (18.3% more likely to persist), attending a</p>
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<p>Lourdes, D. A. (2015). <i>A new perspective on underrepresented</i></p>	<p>Use the voices of underrepresented students who have</p>	<p>Constructivist Qualitative Multiple Case Study</p>	<p>Purposeful Sampling- 12 underrepresented students (first-</p>	<p>Domain and Componential Analysis Validation strategies:</p>	<p>public institution (4.1% more likely to persist with each 10,000 enrollment increase), social life satisfaction (16.7% more likely to persist), and financial aid (6.4% more likely to persist with each \$1,000 increase). Intersectionality of being a female, Hispanic and low-income first-generation student lowered persistence whereas being female Hispanic, low-income continuing-generation student didn't lower persistence. Concerning in college experiences for first-generation students, academic integration (interaction with faculty) .00**, first year GPA .12**, social life satisfaction .16**, grant aid received .02**, and work study received .06* has a significant positive impact on persistence. Engagement wasn't related to persistence.</p>
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student completion: Self-efficacy beliefs of successfully completed underrepresented students. Available from ProQuest Dissertations and Theses Full Text. (3715081)

successfully completed a baccalaureate degree to investigate if and how their higher education self-efficacy beliefs have developed.

generation, low-income-Pell eligible, students of color) that participated in the McNair TRIO program and graduated from a four year public university. In- depth semi-structured interviews.

External audit from dissertation advisor, researcher memo writing, included position of the researcher, in depth rich description, multiple cases to replicate the process.

faculty, staff and peers from common backgrounds Support systems for underrepresented students should be aware of ways to raise self-efficacy, understand how students view success (i.e. grit not GPA).

Martin, L. G. (2012). *Getting out, missing out and surviving: the social class experiences of white, low-income first-generation students.* Retrieved from <http://ir.uiowa.edu/etd/2937>

Explore how white first-generation students from low-income SES backgrounds experience and navigate social class during college.

Constructivist/Critical Qualitative: Phenomenological

Seven first-generation, Pell eligible, White undergraduate students who have completed at least two semesters at a large four year public institution. Semi structured 60 minute individual interviews and participant journals between first and second interviews.

Triangulation of interviews and journals, peer review in checking transcripts, clarifying research bias, sharing data construction with participants, and rich descriptions in the study for transferability.

Overall participants were keenly aware of how their social class in college differed from dominant middle class, it was apparent that this identity influenced their self-perceptions and world view, but they minimized the salience of social class and they didn't want the identity to define them. The participants emphasized the importance of hard work, self-sufficiency and financial responsibility, worked long hours which impacted involvement in college, and were often frustrated with attitudes, values and behaviors of high SES peers. The participants had a desire to attain a college degree for

<p>Olive, T. (2009). <i>Desire for higher education in first-generation Hispanic college students enrolled in the McNair Post Baccalaureate Achievement Program</i>. ProQuest Dissertations & Theses Full Text database (UMI 3368984)</p>	<p>Desire to attend college with First-Generation Hispanic College Students Enrolled in the McNair Post baccalaureate Achievement Program.</p>	<p>Constructivist Qualitative: Phenomenology</p>	<p>One-hour taped interviews with five first-generation Hispanic (seniors 20-22 years old) participants enrolled in McNair, (some immigrants and English as a second language).</p>	<p>Clarified researcher bias, member checking by discussing finding with participants, and rich, thick descriptions of the participants.</p>	<p>reasons of personal fulfillment and to be in a career that they are passionate about-rather than a high paying job.</p> <p>The desire for higher education was in response to limitations evident with uneducated family members, self-efficacy and goal orientation in past academic endeavors, and strong emotional connection to family integrated with benefit of education. A theme shared was rejecting and embracing family values simultaneously. Deficits were countered by encouragement from family members, and challenges were opportunities to demonstrate resilience, self-discipline and motivation. The participants shared altruistic motivation to contribute to others in society, break away from tradition, and be involved in a process of self-discovery. Participant's interaction with faculty resulted in a growing awareness of</p>
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<p>Orbe, M. P. (2004). Negotiating multiple identities within multiple frames: An analysis of first-generation college students. <i>Communication Education</i>, 53(2), 131-149.</p>	<p>Explore saliency of first-generation student status.</p>	<p>Constructivist Qualitative: Phenomenology</p>	<p>79 first-gen across six different campuses including 8 graduate students, 24 nontrad. Thirteen focus groups, four individual in-depth interviews.</p>	<p>Member checking with focus groups after interviews to gather feedback on themes.</p>	<p>intellectual curiosity, academic potential, increasing autonomy, and career opportunities.</p> <p>First-generation saliency was influenced by the situational context (more salient at home than school) and institutional type- (negative stigma at private universities), and varied greatly in daily interactions. At home some participants were given a lot of attention and for others it was a point of contention with friends expressing that they were too good to hang out with them. At college, it was more important for students that identify with co-cultural group including low-income. The first-generation identity appears to lack a significant sense of communal identity; if they were supportive of each other it was usually with two individuals.</p>
<p>Pascarella, E. T., Pierson, C. T.,</p>	<p>How first-generation students experience</p>	<p>Post-Positivist-Quantitative:</p>	<p>3,331 second- and third-year students</p>	<p>Pre-college survey, Collegiate Assessment</p>	<p>Significant first-generation deficit</p>

Wolniak, G. C., & Terenzini, P. T. (2004). First-generation college students: Additional evidence on college experiences and outcomes. *Journal of Higher Education*, 75(3), 249.

college and benefit from college.

Difference and Prediction

participating in the National Study of Student Learning- 18 four year colleges for 3 years (Fall 1992-Spring 1995). Three levels to define first-generation- parents with no college, some college, and bachelor's degree.

of Academic Proficiency - developed by ACT, College Student Experience Questionnaire, NSSL questionnaire- appropriate reliabilities First sample-(72.5% response), second follow up- same measurements except the precollege survey (66.8% response), third follow up- same measurements as second follow up (65.3% response). External Validity- weighted samples estimates adjusted to actual sample size, acknowledged self-selection in smaller sample in third data set.

experiences-worked more hours which had a negative impact on their growth during college, earned less credits, less likely to live on campus, lower levels of extra-curricular involvement, lower grades, and fewer courses in the humanities, social sciences, and technical/pre-professional. However, first-generation students benefited more from extracurricular involvement, classroom activities such as studying and writing papers, and taking general education courses than continuing-generation students. College Outcomes- not a large difference between first-generation and continuing-generation. Despite disadvantages of first-generation status, students who persisted appeared to be sufficiently resilient and didn't have negative cognitive and non-cognitive outcomes. However, at the end of

<p>Phinney, J. S., & Haas, K. (2003). The process of coping among ethnic minority first-generation college freshmen: A narrative approach. <i>Journal of Social Psychology</i>, 143(6), 707-726.</p>	<p>Investigate how situational factors, social support, and personal characteristics contribute to successful coping of underrepresented students.</p>	<p>Pragmatic: Mixed-Methods- Narrative Inquiry</p>	<p>Purposeful sampling with 30 freshmen predominantly first-gen narrowed down to six students, three who were on the high end of self-efficacy and three who were on the low end.</p>	<p>A background survey (demographics/descriptive) and weekly journaling on students' stress, ways of coping with stress, and resources needed to deal with the stress were gathered. The authors spent a lot of time explaining the value of qualitative research but didn't share their voice and perspectives. Mentioned trail coding of students who dropped out of the study, and three coders shared kappa of intercoder reliability.</p>	<p>the third year, first-generation students had higher internal locus of control and preference for higher cognitive tasks than continuing-generation students.</p> <p>The findings in this study were that those more successful in coping with stress reported a greater sense of self-efficacy (believing that they could succeed) and felt that they had social support. Seeking support rather than proactive coping was the most successful strategy $F(5.79) = 2.99, p = .016$, and demographic attributes and the type of stress didn't impact the coping success.</p>
<p>Pike, G. R., & Kuh, G. D. (2005). First- and second-generation college students: A comparison of their engagement and intellectual development. <i>The Journal of Higher</i></p>	<p>Compare first-generation and continuing-generation students' background characteristics, engagement, and learning intellectual development.</p>	<p>Post-Positivist-Quantitative: Difference and Prediction</p>	<p>1466 first-year students from each institutional Carnegie classification.</p>	<p>College Student Experiences Questionnaire-Academic engagement-library experiences, active and collaborative learning, writing experiences, interactions with</p>	<p>First-generation students were less engaged, less likely to integrate diverse college experiences, perceived college to be less supportive and less progress in learning and intellectual</p>

Education, 76(3), 276-300.

Pizzolato, J. E. (2003). Developing self-authorship: Exploring the experiences of high-risk college students. *Journal of College Student Development*, 44(6), 797-812.

Explore self-authorship with high-risk college students.

Constructivist Qualitative: Grounded Theory

Purposeful sampling with 35 high-risk college students (e.g. first-generation, low-income-wasn't defined) recruited from support programs, (recruited more from high achieving high risk female students) and revenue sport athletes. Some were first-year students.

faculty, Social engagement- personal experiences, student acquaintances, and topics of conversation, Gains in learning and intellectual development-gains in general education, communication skills, interpersonal development, intellectual development. Goodness of fit scales.

Demographic questionnaire and semi-structured hour interviews that centered on students' stories about experiences and decisions they identified as important, in order to examine students' ways of knowing cognitively, interpersonally and interpersonally. Trustworthiness was determined with two other coders who were first-generation student graduates. The majority of codes were consistent and the one area of inconsistency between the coders was redefined.

development; however, most of the differences were due to educational aspirations and where students lived rather than generational status. Differences between first- and second-generation students weren't very meaningful.

Some of the high-risk college students developed self-authoring ways of knowing prior to enrollment in college, especially emerging from provocative experiences (e.g. going to jail, brother killed by gang members). Students dealt with these experiences by considering making changes or committing to new goals such as going to college. Self-authoring ways of knowing appear to arise from students' willingness to process provocative interpersonal experiences. Lack of

<p>Prospero, M., & Vohra-Gupta, S. (2007). First-generation college students: Motivation, integration, and academic achievement. <i>Community College Journal</i>, 31(12), 963-975.</p>	<p>Motivation and integration dimensions that influence college academic achievement of first-generation compared to non-first-generation students.</p>	<p>Post-Positivist-Quantitative: Difference and Prediction</p>	<p>197 ethnically diverse students attending a community college taking a general psychology course.</p>	<p>Surveys at the beginning of a class period, that measured motivation and social and academic integration (satisfactory reliability-alpha .89).</p>	<p>privilege in the college admission process often required them to self-author by creating their own formulas for success. High privilege students that had excessive support such as student athletes didn't have the same opportunities to develop self-authorship.</p> <p>Motivation and integration dimensions contributed significantly to academic achievement of first-generation students, but not with non-first-generation students. For first-generation students' academic integration (class attendance, study time) contributed to higher grade point averages, while extrinsic motivation (originates outside of an individual) and a motivation (perceive behaviors as outside of individuals control) contributed significantly to lower grades. No differences in level of college motivation or integration between</p>
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<p>Reid, M. J., & Moore, J. L. (2008). College readiness and academic preparation for postsecondary education: Oral histories of first-generation urban college students. <i>Urban Education</i>, 43(2), 240-261.</p>	<p>Explore the perceptions and attitudes that first-generation, urban college students have of their preparation for postsecondary education, including the strengths and weaknesses of their preparation experiences.</p>	<p>Constructivist Qualitative: Grounded Theory</p>	<p>Thirteen first-generation students (e.g. all African American or immigrant, 12 below poverty level-qualifying for free or reduced lunches).</p>	<p>Participants completed a biographical questionnaire and an individual interview. Triangulation with a questionnaire and interviews, and each research team member individually coded the data, and then the team negotiated consensus in determining the coded themes.</p>	<p>first-generation and non-first-generation. Factors that helped with college success included taking AP courses, especially English; having encouraging teachers and counselors, being involved in high school activities, and participating in college preparation programs. Students shared that they lacked academic skills in some coursework such as math and science, needed better study skills for college-level work, and had poor time management skills.</p>
<p>Stephens, N. M., Fryberg, S. A., Markus, H. R., Johnson, C. S., & Covarrubias, R. (2012). Unseen disadvantage: How American universities' focus on independence undermines the academic performance of first-generation college students. <i>Journal of Personality and Social Psychology</i>, 102(6), 1178-1197.</p>	<p>Research a cultural mismatch theory that identifies one important source of this social class achievement gap which is that first-generation students underperform because interdependent norms from their mostly working-class backgrounds constitute a mismatch with middle-class independent norms prevalent in</p>	<p>Post-Positivist Quantitative: Experimental</p>	<p>First Study-60 top universities (US News and World Report), Second study-1424 students at a private institution, Third study-88 first year students.</p>	<p>First Study-survey with a pilot survey, Second study- on-line survey on motives of coming to college before they started and completed a factor analysis, tracked students grades for two years, Third study- participants read a welcome letter and completed a verbal reasoning test to assess different learning styles. Completed a manipulation check to</p>	<p>First Study- Universities were characterized as more independent $\chi^2(1, N = 261 = 120.0, p = .000)$. Second study- First-gen selected more interdependent motives compared to cont gen students $b = .13 t(1311) = -6.5, p = .000$. Controlling for race and SAT scores, motives toward interdependence negatively impacted grades at the end of the</p>

universities.

determine if the welcome letter effectively manipulated participants' perceptions of the university culture.

first year $b = .04$ $t(1298) = 1.8, p = .07$, with the same results for the second year. Third study- when first-generation students read the interdependence culture letter they had verbal reasoning ratings that were similar to continuing-generation students $F(1,38) = 4.2, p = .049$ which eliminated the gap. When first-generation students read the independent culture letter they had lower verbal reasoning $F(1, 38) = 6.1, p = .02$.

Stephens, N. M., Hamedani, M. G., & Destin, M. (2014). Closing the social-class achievement gap: A difference-education intervention improves first-generation students' academic performance and all students' college transition. *Psychological Science*, 25(4), 943-953.

Test an intervention (student panel sharing background information and college information) to decrease the social class achievement gap for first-generation students.

Post-Positivist
Quantitative:
Experimental

147 incoming students at a private university.

Intervention- students attended an hour long workshop with seniors talking about college adjustment, (one group talked about college adjustment linked to social class backgrounds and the other group just talked about college adjustment e.g. how I talked to the professor as a first-generation student as opposed to just saying go talk to you professor); also compared to students that didn't complete the

Difference Education Intervention: Students that attended the difference education panel had statistically significantly higher responses that people's different background matter (16.9 more responses) and people's background like mine can succeed (33.72 more responses) than students that attended the panel without difference education $p > .001$. Academic Performance: Controlling for

<p>Stuber, J. M. (2011). Integrated, marginal, and resilient: Race, class, and the diverse</p>	<p>Persistence patterns of white first-generation students</p>	<p>Constructivist Qualitative: Phenomenology</p>	<p>28 white first-generation working class sophomore and junior students from a</p>	<p>workshop. Data Collection-participants completed a short survey and created a video testimonial articulate what they learned at the panel, students' first year cumulative GPAs, survey completion at the end of the year to access students' retention of the workshop and tendency to use campus resources. Reliability and validity-two outside coders achieved reliability, disagreements through consensus, post intervention manipulation check-participants completed a short survey and created a video testimonial articulate what they learned at the panel, and mediation analyses to examine whether differences in seeking college resources explained the generational status and intervention condition.</p>	<p>preexisting differences in students' demographics or academic skills, first-generation students who participated in the difference education intervention had statistically significantly higher GPAs than students who participated in the standard intervention $F(1,53) = 14.61, p = .004$, Cohen's $d = .7$. Seeking College Resources: Significant generation status and intervention condition $F(1,129) = 3.99, p = .048$.</p> <p>Although there were a lot of diverse student experiences, the results described three general</p>
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experiences of white first-generation college students. *International Journal of Qualitative Studies in Education (QUE)*, 24(1), 117-136.

Terenzini, P. T., Springer, L., Yaeger, P. M., Pascarella, E. T., & Nora, A. (1996). First-generation college students: characteristics, experiences, and cognitive development. *Research in Higher Education*, 37(1), 1-22.

First-Generation College Student characteristics, experiences, and cognitive development.

Post-Positivist-Quantitative: Difference and Prediction

large state university and a small liberal arts institution. Systematic random (got list and then sent an email) and purposeful sampling from programs targeted for first-generation students. Working class was defined as parents or guardians in occupations with lower levels of skills, lower pay and limited autonomy.

2,685 students 825 first-gen who entered 23 diverse institutions nationwide in fall 1992 and completed one year of study.

bias, and gathering rich thick descriptions with five months between interviews.

Collegiate Assessment of Academic Proficiency (CAAP)- part of ACT- 40 minute multiple choice modules in reading, math, and critical thinking. Internal consistency reading-.84 and .86, math .79-.81, and critical thinking .81 to .82. Critical thinking was correlated with Watson critical thinking- .75. After one year retook CAAP and took College Student Experiences

patterns of adjustment Integrated persisters-1/2 feelings of marginality-well integrated, Alienated persisters-1/4 persistent and debilitating marginality, Resilient and motivated persisters-1/4 overcame feelings of marginality and appeared well integrated-transforming marginality to motivation for social change. Working class was considered an asset, and whiteness was an asset and a liability.

Largest difference was income and being Hispanic, lower critical thinking and less educational aspirations, less encouragement from family to attend college, less time socializing with peers and talking with teachers in high school, and more likely to be women. First-generation students scored lower in math and reading, take fewer courses in humanities and fine arts, complete fewer credit hours,

<p>Wilbur, T. G., & Roscigno, V. J. (2016). First-generation disadvantage and college enrollment/completion.</p>	<p>This study explored the differences of college attendance and graduation between first-generation and non-generation taking</p>	<p>Post positivist</p>	<p>Data were first collected in 2002, with 750 high schools and 16,197 10th grade students. Follow-up was conducted in 2004,</p>	<p>Questionnaire.</p> <p>Data came from surveys and the Educational Longitudinal Study. The study examined mean differences of</p>	<p>spend fewer hours studying and participate less in honors, worked more hours, less likely to see faculty as concerned for student development, less likely to participate in a racial awareness workshop, and got less encouragement from friends to continue college. There was no difference between first-generation and continuing-generation in gains of math and critical thinking, although traditional students had greater gains in reading. First-generation benefited more in their reading skills from studying more hours. Hours worked off campus promoted reading gains, and completing more hours had a strong positive effect on gains in critical thinking skills among first-generation students.</p> <p>On average, first-generation students are 70% less likely to enroll in a four-year college than are their non-first-generation students, and</p>
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Socius, 2, 1-11.

into account SES status

when the students were high school seniors, in 2006 and 2012 with a focus on 4 year schools. Surveys were used to measure cultural capital and parental involvement in high school; and college experiences and stressors. Controlled gpa, gender, ethnicity, and rural status.

attending college, and logistical regression of likelihood of attending and graduating from college.

60% less likely to complete their bachelor's degree compared to their non-first-generation peers. First-generation students are significantly less likely to be involved in extracurricular and high impact activities, and likely to work longer hours, live at home, and experience personal and family-related stressful events. The first-generation disadvantage persists even when SES is accounted for.

APPENDIX B

Participant Information

Consent to Participate in a Research Study

Colorado State University

TITLE OF STUDY: *Progress through Calculus*

PRINCIPAL INVESTIGATOR: *Jess Ellis, PhD, Mathematics Department,*

ellis@math.colostate.edu

GRADUATE STUDENT INVESTIGATOR: *Gaye DiGregorio, Higher Education Leadership,*

gaye.digregorio@colostate.edu

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?

You are being invited to participate in this research project because you are enrolled in a course in the Precalculus to Calculus II (P2C2) sequence this semester.

WHO IS DOING THE STUDY? This research is being conducting under the scope of the Mathematics Association of America (MAA) and involves researchers from multiple universities. Doug Ensley (MAA), David Bressoud (Macalester College), Chris Rasmussen (San Diego State University) and Sean Larsen (Portland State University) are the other PIs of the project. Estrella Johnson (Virginia Tech University) is a senior personnel. Graduate students from Colorado State University, San Diego State University, and Portland State University are also part of the research team. This work is funded through the National Science Foundation (NSF DUE 1430540).

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to explore first-generation, Pell recipient students' experiences with math placement and pre-calculus/calculus math courses. More specifically, this study focuses on how university factors influence the self-belief of first-generation, Pell recipient students to be successful in math and how experiences in math influence first-generation low-income students' self-belief in being successful in college.

WHAT WILL I BE ASKED TO DO?

A small group of students will be invited to participate in three 60 minute interviews (some may be Skype Interviews) for a total commitment of 180 minutes, and a focus group interview lasting up to 60 minutes. Interviews and focus groups will be audio recorded and Skype interviews will be video recorded solely for note-taking purposes. Recordings of focus group and individual interviews will never be made public.

ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY? You should only participate in this research if you are enrolled in the *P2C2 sequence with the research team*.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

There are no known risks associated with this research. Digital recordings will never be made public. In the case of audio transcriptions, pseudonyms will be used at all times to protect the identity of all participants. Observations are for research and mentoring, and will not be used for evaluative purposes.

It is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?

There may be no direct benefit to you from participating in this research, but you may find the various opportunities to reflect on your own experiences as a first-generation Pell recipient student with mathematics. The information gained from this study may help us better understand what it takes to support student success.

DO I HAVE TO TAKE PART IN THE STUDY?

Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without time without adversely affecting your relationship with the investigators, the Colorado State University, or the Mathematics Department. Your decision to participate or not will have no impact on your course grades.

WHO WILL SEE THE INFORMATION THAT I GIVE?

We will keep private all research records that identify you, to the extent allowed by law.

For this study, we will assign a pseudonym to your data (ex. School2Student4) so that the only place your name will appear in our records is on the consent and in our data spreadsheet which links you to your code. Only the research team at the associated institutions will have access to the link between you, your code, and your data. The only exceptions to this are if we are asked to share the research files for audit purposes with the CSU Institutional Review Board ethics committee, if necessary. In addition, for funded studies, the CSU financial management team may also request an audit of research expenditures. For financial audits, only the fact that you participated would be shared, not any research data. When we write about the study to share with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish in educational journals or present at

educational meetings the results of this study; however, we will keep your name and other identifying information private. In instances where data are not reported as aggregated, pseudonyms for students will be used, and all other identifying information will be disguised to protect your identity.

For the focus group, confidentiality will be maintained to the extent that other focus group participants do not share group information outside the session. The data will be stored in a locked cabinet in the investigator's office or on a password-protected hard drive, and will only be seen by the investigators and research staff during the study and for five years after the study is complete. The original audio recordings will be erased after transcription and analysis.

WILL I RECEIVE COMPENSATION FOR MY PARTICIPATION?

Upon completion of three interviews and participation in a student focus group, you will receive a \$50 Amazon gift card. Your identity/record of receiving compensation (NOT your data) may be made available to CSU officials for financial audits

WHAT IF I HAVE QUESTIONS?

Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Dr. Jess Ellis at ellis@math.colostate.edu or Gaye DiGregorio at gaye.digregorio@colostate.edu. If you have any questions about your rights as a volunteer in this research, contact the IRB Coordinator at: the CSU IRB at:

RICRO_IRB@mail.colostate.edu; 970-491-1553. We will give you a copy of this consent form to take with you.

Please initial by each research activity listed below that you are volunteering to participate in.

- I will participate in three interviews ____ (initials)
- I will participate in a focus group ____ (initials)

Do you give permission for the researchers to contact you again in the future to follow-up on this study or to participate in new research projects? Please initial next to your choice below.

- Yes _____ (initials)
- No _____ (initials)

Participant confirms participation in multiple activities (list):

Permission to re-contact:

Permission to audiotape/vidiotape interviews and/or focus groups:

Your signature acknowledges that you have read the information stated and willingly sign this consent

The researchers would like to audiotape your interview and/or focus group to be sure that your comments are accurately recorded. Only our research team will have access to the audiotapes, and they will be destroyed when they have been transcribed.

Do you give the researchers permission to audiotape your interview and/or focus group? Please initial next to your choice below.

- Yes, I agree to be digitally recorded _____ (initials)
- No, do not audiotape my interview _____ (initials)

form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 3 pages.

Signature of person agreeing to take part in the study

Date

Printed name of person agreeing to take part in the study

Name of person providing information to participant

Date

Signature of Research Staff

Consent to Participate in a Research Study

Colorado State University

APPENDIX C

Survey Questions

Student Interview Questions

Thank you for taking the time to participate in this interview and share your experiences with math. You have been selected for this interview because you are first-generation students which mean that you are one of the first in your family that is going to earn a college degree and you are a recipient of the Pell Grant to provide federal financial support for your education. So first of all, congratulations for being a pioneer to your family and developing your path in college. My name is Gaye DiGregorio and I'm interested in learning more from you because this is the focus of my graduate study research. This is one of three interviews that is part of a large-scale study by the Mathematical Association of America to learn more about your experiences in Pre-calculus, and Calculus I. Our goal is to apply what we learn from your experiences to improve math progression across the country and to give a voice to your student experience. All the interviews will all be approximately 60 minutes long, the second interview will be ____ and the third interview will be _____. I also want to assure you that your name will not be disclosed or identified in later reports. Feel free to skip any questions you do not feel comfortable answering, and you may ask me to stop to interview at any time. To assure accurate representation and reporting of our discussion later on, I will be audio-recording our conversation. Is that okay with you? Are there any questions before we start?

Interview One: Building a Rapport/ Student Background/Math Placement

Student Background and General College Experiences

For you, what does it mean to be the first or one of the first in your family (first-generation) to attend college? *Student Experiences*

a) Probe for perceptions of family and friends of college attendance, pathway to college
Tell me about an occurrence or story that illustrates your experience as a first – generation student? *Student Experiences*

a) Probe for benefits and challenges

Share a story that sticks out in your mind about your college experience as a Pell Grant recipient. *Student Experiences*

a) Probe for benefits and challenges, and other identities that may be impacting the student's experience

Describe an experience that highlights your success in college? *Student Experiences*

Tell me about your most challenging moment in college thus far. What steps have you taken to manage/cope with this challenge? *Student Experiences*

a) Probe for what resources or services were used in these moments.

Who has been influential in your college experience? *Student Experiences*

Math Placement

Tell me about your experience with the math placement process? What feelings came up for you? *Student Experiences*

a) Probe for university messages (advisers, websites, emails, math department faculty and staff, college students) and how these messages influenced the experience

University factors influence on self-belief: Self-efficacy- Verbal Persuasions, Stereotype threat

b) Probe for helpful components, frustrations and pressures, and how the student responded to challenges - *Student Experiences: Self-efficacy- Physiological and Affective States, Growth Mindset*

Affective States, Growth Mindset

What are your reflections about your math placement experience now? *Student Experiences*

Experiences

a) Probe for university messages and how these messages influenced the experience

University factors influence on self-belief: Self-efficacy- Verbal Persuasions, Stereotype threat

b) Probe for self-reflection on student's performance, what could have been done differently, and what the math department/university could do to enhance the math placement. *Student Experiences, University factors influence on self-belief*

How do you think your identity as a first-generation impacted your math placement experience? *Student Experiences*

How do you think your identity as a Pell recipient impacted your math placement experience? *Student Experiences*

How do you respond to the statement- I believe that my math ability can be improved through dedication and hard work? *Student Experiences: Growth Mindset*

How would you describe your belief about being successful in college math and what could make it even stronger? *Student Experiences, University factors influence on self-belief: Self-efficacy- Physiological and Affective States, Self-belief*

Interview Two: Experiences with Pre-calculus/ Calculus Courses

Describe your experience so far in [insert math course]. *Student Experiences*

a) Probe for university messages and how these messages influenced the experience

University factors influence on self-belief: Self-efficacy- Verbal Persuasions, Stereotype threat

b) Probe for helpful components, frustrations and pressures, and how the student responded to challenges. *Student Experiences: Self-efficacy- Physiological and Affective States, Growth Mindset*

States, Growth Mindset

Tell me about someone that is influential in your experience in [insert math course]?

Student Experiences, University factors influence on self-belief

a) Probe for relationships/interactions with faculty, fellow students, staff *Self-efficacy- Verbal Persuasions, Vicarious Experiences, Stereotype threat*

Share when you were confident that a program and/or activity have influenced your experience in the course? *Student Experiences*

Describe an experience that illustrates your sense of belonging in your math course?

Student Experiences

a) Probe about student's knowing or seeing other students who share identities in the math class? *Self-efficacy -Vicarious Experiences*
 Share a story about how your identity as a first-generation is impacting your experience in [insert math course]? *Student Experiences*
 Tell an experience about how your identity as a Pell recipient is impacting your experience in [insert math course]? *Student Experiences*
 Do you think the university is supporting you in being successful or is it mostly up to you to be successful in your math class? How about college in general? *University factors influence on self-belief*
 How does this university support or lack of support influence your current experience with the course? *University factors influence on self-belief: Self-belief, Stereotype threat*
 Anything else you would like to add you're your experience in this course thus far?

Interview Three: Reflecting on pre-calculus/calculus course experiences

Reflect on your overall experience in math during the fall semester. *Student Experiences*

a) Probe for university messages and how these messages influenced the experience
University factors influence on self-belief: Self-efficacy- Verbal Persuasions, Stereotype threat

b) Probe for helpful components, frustrations and pressures, and how the student responded to challenges. *Student Experiences: Self-efficacy- Physiological and Affective States, Growth Mindset*

c) Probe for self-reflection on student's performance, what could have been done differently, and what the math department/university could do to enhance the math course. *Student Experiences: Self-efficacy-Mastery Experiences, University factors influence on self-belief*

What are you most proud of concerning your experience in the fall semester math course? *Student Experiences: Self-efficacy-Mastery*

Tell me about someone that was influential in your experience in [insert math course]? *Student Experiences, University factors influence on self-belief*

a) Probe for relationships/interactions with faculty, fellow students, staff *Self-efficacy- Verbal Persuasions, Vicarious Experiences, Stereotype threat*

Share when you were confident that a program and/or activity influenced your experience in the course? *Student Experiences, University factors influence on self-belief*

Please share how the experience in [appropriate math course] changed your belief in being successful in math?

Please respond to this statement. Your belief that your math ability can be improved with dedication and hard work? *Student Experiences, University factors influence on self-belief: Self-belief, Stereotype threat*

Share a story about how your identity as a first-generation is impacting your experience in [insert math course]? *Student Experiences*

Tell an experience about how your identity as a Pell recipient is impacting your experience in [insert math course]? *Student Experiences*

How did your performance in the math course influence your belief in being successful in college? *Student Experiences: Self-belief, Stereotype threat*

Are there any questions you wished I had asked?

APPENDIX D

Focus Group Questions

Introduction

Thank you for taking the time to come this to focus group and share your experiences with math. All of you are first-generation students which mean that you are one of the first in your family that is going to earn a college degree. So first of all, congratulations for being a pioneer to your family and developing your path in college. My name is _____ and I'm interested in learning more from you because _____. An additional introduction will be done from the researcher taking notes. This is one of several meetings being held nationally with students to learn more about your experiences in math. Our goal is to apply what we learn from your experiences to improve math progression across the country. We promise to only take about an hour and a half of your time. I also want to assure you that your names will not be disclosed or identified in later reports. We are only interested in getting your comments as a group. No individual names will in any way be connected to the comments you provide during our discussion. I would also ask that you keep the identities and comments of other students in the room confidential. To assure accurate representation and reporting of our discussion later on, we will be audio-recording our conversation. Are there any questions before we start?

Questions

Write down one or two words that capture your experience as one of the first in your family to attend college. The words could be posted around the room.

Please share what your experience has been like to be one of the first in your family to attend college?

From the interviews that I had with all of you, some themes about your experiences with math emerged. What do you think about these themes?

I also came up with other themes about the university messages about math placement and math completion from your interviews and my observations. What are your thoughts about these themes?

Could you share some stories about a person or resource that positively influenced your experience in math?

How has being a first-generation student influenced your experience in math?

What recommendations do you have for the university in order to enhance your experience with math placement, pre-calculus, and calculus?