

**UNDERSTANDING THE UNDERREPRESENTED MINORITY
EXPERIENCE IN UNDERGRADUATE CALCULUS COURSES**

by

Alexandra G. Reid

An executive position paper submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

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DEDICATION

This paper is dedicated to the late Julia Lewis Reid and Clifton “Gator” Lewis. Thank you for watching over me and helping me see this through.

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ABSTRACT

The purpose of the study was to investigate the experiences of underrepresented minority (URM) students enrolled in calculus courses at the University of Delaware. Coupling qualitative research methodology with critical race theory and social cognitive theory, the researcher chronicled the experiences of seven students negotiating the achievement gap in mathematics at this primarily white institution. The study allowed the students to explore their perceptions of access to mathematics, academic achievement in mathematics, and the effect of race and/or racism on their performance in college mathematics. While the national trend shows that underrepresented students earn lower overall grade point averages than their non-underrepresented counterparts, there is little specific information about their performance and experience in these courses (Nettles et al., 1986).

A survey conducted by Treisman (1992) found that there are four widely held beliefs about the causes of minority (underrepresented) student failure in college calculus: low motivation, poor academic preparation, lack of family support, and low family income. Research by Bressoud, Carlson, Mesa, & Rasmussen (2013) indicates that students at research institutions offering Calculus I courses are least likely to maintain student confidence in their mathematical abilities, enjoyment of mathematics, and interest in continuing in the mathematics needed to pursue their intended careers. In order to capture the perspectives of underrepresented students taking calculus courses, interviews were conducted with participants targeted through an electronic survey instrument. Data analysis was performed through narrative inquiry, using the interview transcripts through a number of lenses such as stories

simultaneously situated within a particular context and within a wider cultural context. Subsequently, analysis of the data indicated that students desire a number of changes within the curriculum, pedagogy, and calculus sequence, including more one-on-one interaction with the course instructor, as well as more collaborative work in the classroom. While microaggressions were also explored in these settings, they were shown not to have a significant impact on the success of the targeted participants.

Chapter 1

INTRODUCTION

The white and ethnic minority student achievement gap, which is often first measured by standardized tests in elementary school, actually begins well before students reach kindergarten as a “school readiness” gap (Brooks-Gunn & McLanahan, 2005). Known as the “Matthew Effect,” this early disparity in performance is critical because once students are behind academically they do not catch up, and the gap can widen through post-secondary grade levels. There is little research regarding mathematics achievement of postsecondary minority students who enroll in college mathematics courses. What research does exist indicates that mathematics scores for ethnic minority students in grades 4 and 8 have increased slightly in recent years, but there is a need to improve the performance of older students (National Assessment of Educational Progress, 2007). Research literature on the ways to facilitate successful mathematical learning and problem-solving for ethnic minorities is insufficient (Secada, 1992). However, success in mathematics for ethnic minorities may be facilitated if these students are immersed in a curriculum that incorporates alternative instructional modalities and platforms that accommodate the students’ learning styles (Armstrong, 2007).

Background

Underrepresented college students are viewed as those students who have historically been denied access to higher education for any number of reasons or

excuses. Generally, underrepresented students include first-generation citizen students, low-income students, and ethnic/racial minority students, many of whom have been underserved in post-secondary programs (Dockery & McKelvey, 2013). According to educational assessment entities, such as the National Council of Teachers of Mathematics (Cuevas & Driscoll, 1993) and the National Mathematics Advisory Panel (National Council of Teachers of Mathematics, 2008), there is room for improvement in mathematics and science instruction.

Many ethnic minority students find it difficult to achieve high grades in mathematics (Berry, 2003), and the limited research indicates several factors that lead to the failure of many of these students in college mathematics courses. Factors that contribute to these failures include, but are not limited to: low expectations for student achievement (Hart, 2003); culturally unfriendly environments (Ladson-Billings & Tate, 1995); poor teacher preparation (Martin, 2009); and inadequate materials, equipment, and resources that included technology-based resources (National Education Association, 2014). These factors are cumulative at the K-12 level, but many are carried through to post-secondary levels (Hart, 2003; Ladson-Billings & Tate, 1995; Oakes et al., 2001; National Education Association, 2014).

Factors outside of the school's control include: family income level (Oakes et al., 2001); access to libraries, museums, and other institutions that support student development (National Education Association, 2014); student diet and nutrition (Davis, 2003); and a variety of societal biases (racial, ethnic, poverty, and class) (Ladson-Billings & Tate, 1995). In an effort to find solutions, researchers and educators invested in social justice have put forth suggestions and efforts to close

current gaps in education between students of different backgrounds. Alarming inequalities in the allocation of resources in American schools may account for the disparities in mathematics achievement, which have continued to show up in students' assessment scores and course enrollment patterns (Berry, 2003). Berry (2003) points out that "...African-American students receive mathematics instruction that is not consistent with mathematics education reform" (p. 1). Strong & Perini (2004) posit that the mathematics education that many ethnic minorities receive is in opposition to their cultural styles and learning preferences. While many of the identified basic problems of achievement remain the same across institutions, proposed solutions should meet the needs of the individual institution's population.

Statement of the Problem

The high school graduation rate for African-Americans is about 52% and for Hispanic/Latin@s¹ is about 57% in today's society (United States Department of Education, 2008). For those who do graduate from high school and enroll in college, their secondary educational environments may be damaging, intimidating (Freeman, 1997), and isolating (Turner, 1994). It is common that many of these students,

¹ For the purpose of this investigation, the designation *Latin@* is used. This designation is used by Miranda, Webb, Brigman, & Peluso (2007) to denote individuals of an original Spanish culture; members identify themselves as associated with, or as citizens of, Mexico, South America, Puerto Rico, or Spain. The "@" is used to establish gender neutrality.

including about 48% of African-Americans and 43% of Hispanic/Latin@s, are not adequately prepared for college (Hood, 2012). Interventions remain warranted to keep underrepresented students in higher education, especially in the Science, Technology, Engineering, and Mathematics (STEM) programs. For example, according to 2010 data from the National Science Foundation and the U.S. Census Bureau, underrepresented minorities earned 18.6 percent of total undergraduate degrees from 4-year colleges, but only 16.4 percent of the degrees in science fields and less than 13 percent of the degrees in physical sciences and engineering (Jones, 2013).

While ethnic minority students, specifically African-Americans and Hispanic/Latin@s express a strong interest in mathematics, science, and engineering majors upon college entrance, they are highly underrepresented among college graduates in these fields. College calculus is often viewed as a barrier for higher level STEM courses and, consequently, for many careers in specialized fields, including mathematics, the sciences, engineering, and medicine, as well as in some areas of business (Moreno, Muller, Asera, Wyatt, & Epperson (1999). Although these students earn lower overall grade point averages than their non-minority counterparts, specific information about their performance in introductory calculus courses has not been investigated (Nettles et al., 1986).

Historically, the majority of underrepresented students are not succeeding at the same rate as their non-underrepresented counterparts in the calculus courses offered at UD. For example, the rates for dropout, failure, or withdrawal (D, F, W) of the underrepresented minority (URM) students are higher than non-minority students (white and Asian students). This includes African-American, Hispanic/Latin@,

Pacific Islander, and Native American students. For one section of MATH 241 in the fall of 2014, the DFW rate was 16% as compared to 9.2% for non-minority students.

Table 1 represents the data for subsequent years.

Table 1. Enrollment and DFW rates in 2012 and 2013

	Fall 2012				Spring 2013			
	MATH 221		MATH 241		MATH 221		MATH 241	
Total Enrolled	668		624		333		249	
Underrepresented	83		81		54		36	
Non Underrepresented	585		543		279		213	
Underrepresented D,F,W	n 20	24.1%	n 3	16%	n 13	24.1%	n 12	33.3%
Non Underrepresented D,F,W	n 90	15.4%	n 50	9.2%	n 52	18.6%	n 55	25.8%

Based on findings from research related to mathematics education, student attitudes about mathematics and self-efficacy can propel or limit their success in mathematics (Thomas & Higbee, 1999). Learning environments can affect success, both positively and negatively. Non-productive learning environments increase the levels of anxiety and boredom in students and tend to reduce their success with mathematics. Hopefully, the problems addressed in this Executive Position Paper (EPP) can help determine the unique factors that affect access to mathematics, academic achievement in mathematics, and the effect race or racism has on performance in mathematics. This investigation includes the extent to which different instructional approaches identified in the literature impact the mathematics achievement of our most at-risk and underserved students.

Key Questions

To provide the data needed to review the problem in this study, the investigator conducted mixed methods research using a quantitative survey instrument and qualitative interview protocol. The questions addressed were as follows:

1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?

Importance of the Study

This study provides an overview of mathematic learning experiences from the perspectives of underrepresented minority students (URMs) who have studied mathematics at UD, a predominately white institution (PWI). To claim that all URM students enrolled at PWIs have the same experiences that participants in this study encountered would be shortsighted. The uniqueness of each case has been stressed by allowing the participants' "truth" to be revealed in their own voices. As a result, in

some cases, race rises to the forefront of the participants' experiences. Because racism continues to be entrenched in American society, African-Americans, Hispanic/Latin@s, and other marginalized groups still experience acts of discrimination and microaggressions in the classroom (whether they are covert acts or more overt incidents of racism).

There have been several studies on the benefits of inquiry-based and collaborative learning pedagogies in college mathematics settings in recent years; nevertheless, this research is not specific to the outcomes of underrepresented or underserved learners. Much of the past research examining student experiences has employed a quantitative rather than a qualitative approach (McLoughlin & Padraig, 2009; McLoughlin & Padraig, 2010, Thomas & Higbee, 1996; Kasturiarachi, 2004). This investigation employs a qualitative approach in assessing the classroom experiences of underrepresented minority students at UD and draws upon interviews and a survey as data collection techniques. The investigator is optimistic that this investigation will provide insight to policymakers and educators within the UD community about the complexities of race and its effects on students in learning environments, thereby assisting UD in its institutional goals towards a more inclusive and diverse campus.

Definition of Terms

Key terms used in this EPP are defined here.

- *Access to Higher Education* is the right or opportunity for students to be granted an equal opportunity to participate in postsecondary education that connects to students' experiences (Anderson, 1990).

- *African-Americans* are individuals of African descent who were born and reared in the United States.
- *At-risk* refers to any student vulnerable to academic failure while enrolled at postsecondary institutions (Sadovnik et al., 1994).
- *Diversity* means something that “includes the tangible presence of individuals representing a variety of different attributes and characteristics, including culture, ethnicity, sexual orientation, and other physical and social variables” (Talbot, 1996, p. 381).
- *Equity* is the fair treatment towards all students regardless of race, ethnicity, gender, sexual orientation, different physical abilities, socioeconomic status as it relates to quality, resources, and access to challenging curricula so that students “develop sociopolitical consciousness, develop sense of agency, and develop positive social/cultural identities” (Martin, 2003, p. 14).
- *Latin@* refers to individuals from an original Spanish culture; members identify themselves as associated with, or as citizens of, Mexico, South America, Puerto Rico, or Spain (Miranda et al., 2007). The “@” is used as an alternative to establish gender neutrality.
- *Mathematics self-efficacy* are attitudes and feelings of confidence about mathematics abilities that students bring to mathematical problem solving; the results of which can be used to gauge students’ efficiency for problem solving (Angelo & Cross, 2007).
- *Predominantly White Institution* (PWI) is a college or university in which the majority of the student population is White.

- *Race* is the “notion of a distinct biological type of human being, usually based on skin color or other physical characteristics” (Delgado & Stefancic, 2001, p. 153).
- *Racism* is “any program or practice of discrimination, segregation, persecution, or mistreatment based on membership in a race or ethnic group” (Delgado & Stefancic, 2001, p. 154).
- *Underrepresented Minority (URM)* is defined by the University of Delaware as a classification of racial/ethnic groups that are underrepresented on its campus including African-American, Pacific Islander, Native American, and Hispanic/Latin@.
- *Student success* is the ability of a student to support themselves in society after completing the educational process. Additionally, it means having the ability to:
 - Cooperate and collaborate with others in work, social, and family settings;
 - Make independent decisions based on reasoning supported by facts gathered and analyzed by students;
 - Relate in a positive and constructive manner with family members and other members of the world community; and
 - Take responsibility for one’s own actions and act supportively and compassionately toward others (Messersmith, K. (2007).

While research indicates few underrepresented minority students experience success in mathematics, little research exists as to why some underrepresented

students, particularly African-American and Latin@, experience high achievement in mathematics (Berry, 2008; Stinson, 2008; Guiterrez, 2008). Instead of placing emphasis on the negative experiences of URM students and *fetishizing* the mathematics achievement gap, researchers (Guiterrez, 2008) could also examine the experiences of those that find success in mathematics, particularly students at the collegiate level, where research on the topic is slim.

This study focused on underrepresented minority students enrolled in calculus courses at a predominately white institution. The investigator employed critical race theory (CRT) and social cognitive theory (SCT) as theoretical frameworks to analyze and investigate their mathematics experiences.

Review of the Literature

The literature chosen for this investigation were studies primarily in mathematics achievement of ethnic minorities, particularly African-Americans and Latin@s. Described here is a possible vision for high quality instruction for all students that can be used as a lens for interpreting what these students might experience or prefer. This investigator has attempted to uncover factors that support students' success in general and under-represented students' success in particular. This review includes the following information to guide the study: current pedagogies related to cases of the academic achievement of ethnic minorities, the role of interpersonal and intrapersonal relationships (teacher and student, student and student), variables that affect minority learners, and a summary. It is hoped that the literature can offer a variety of insights and strategies used to target college students' motivation and achievement in mathematics.

Current Representation of African-American Students in STEM

In 2001, African-American students represented approximately 13.3% of incoming freshmen in U.S. colleges, but received only 9% of the conferred degrees (and a nearly statistically identical 8.8% of conferred degrees in STEM fields) granted four years later. African-American degree recipients in 2005 were 60% of the number of incoming freshman four years earlier; a slightly lower 53% of these freshmen who announced an intention to study science or engineering in 2001 earned STEM degrees in 2005. By comparison, white students made up 74.8% of incoming college freshmen in 2001 and received 70.2% of all bachelor's degrees and 67.3% of the STEM bachelor's degrees granted in 2005 (Sasso, 2008). This indicates that African-American high school students and college freshman are slightly more interested in STEM fields than their white counterparts, but the numbers do not translate into conferred degrees. Research shows that cumulative educational disadvantages make it difficult for students to attain the prerequisites needed to earn a STEM degree, rather than a lack of interest by the students. In an interview by Sasso (2008), noted mathematician Roger Perry-Stovall states that "by the time they reach the college level, they have built very poor habits, have seen almost everything somewhere in the high school experience, but know very little about how to solve basic problems. Often coined as an *opportunity gap*, their mathematical preparation is insufficient for the rigors of the college curriculum."

Current Representation of Hispanic/Latin@ Students in STEM

Between 1994-1995 and 2003-2004, the number of Latin@ students enrolling in STEM fields in U.S. colleges increased by 33%, representing nearly ten percent of

all students in STEM fields (United States Government Accountability Office, 2005). However, despite the dramatic increase of Latin@s in the population, Latin@s represent only 3% of the labor force in STEM areas (Crisp & Nora, 2012). Disproportionately low numbers of Latin@ students currently enroll in STEM disciplines (Oakes, 1990), though they are equally as likely to declare a STEM major as white students (Chen & Weko, 2009). As with the secondary education and training of African-American students, mathematics and science training at the secondary level for Latin@ students has been shown to influence their interests in pursuit of STEM careers (United States Government Accountability Office, 2005). Crisp & Nora (2012) noted that "...there is evidence that the number of mathematics, science, and English courses taken by Latin@ high school students serves as a major predictor of choosing a STEM college major." The importance of increasing the number of undergraduate Latin@ students completing degrees in science, mathematics, and engineering has been recognized by Congress in the Goals 2000 Educate America Act (section 102, 5-B-iii). In response, the federal government has allocated billions of dollars in increased funding for post-secondary STEM programs (United States Government Accountability Office, 2005).

Mathematics and Inquiry-based Learning

Inquiry-based learning is a pedagogical method rooted in the constructivist learning theories of Jean Piaget, John Dewey, Lev Vygotsky, Paulo Freire, and others. It was developed as a counter-response to traditional forms of instruction that encourage memorization methods of learning as a shift towards knowledge generation and meaning making. Inquiry-based learning (IBL) is like no other pedagogy because

in it, the content is primary. Unlike many methods of instruction, IBL is not passive; it is a master-apprentice system in which the instructor is the master of the material who guides the apprentice students through the course material (Inquiry-based learning, n.d.). The Modified Moore Method, a process in which students present course content in part or wholly by themselves, creates a more effective mathematical inquiry-based education for students and an atmosphere that can more solidly ground authentic understanding of mathematical principles (McLoughlin & Padraig, 2009). Problem-based learning (or “project-based learning”) exists within inquiry-based learning, a pedagogy used in small-scale investigations, projects, and research.

Based on the findings of Michael Prince and Richard Fielder (2007), IBL appears to be more effective than traditional instruction at improving academic achievement and developing problem-solving (2007). Indeed, recent studies suggest that undergraduate students’ ideas of mathematics, proofs, and their own role in mathematics may be affected by the social norms and classroom practices that emphasize student activity, PBL, and intrapersonal student and teacher classroom discussions (Smith, 2006; Jensen, 2006; Kwon, Ramussen, & Allen, 2005; Ju & Kwon, 2007; Ramussen et al., 2006). In a large, mixed methods study conducted by Laursen, Hassi, Kogan, Hunter, & Weston (2011), four college campuses where mathematics “IBL Centers” had been established were examined in courses ranging from introductory to advanced levels. Student records for over 5000 students were obtained by this study so that patterns in student achievement could be examined. It was determined that IBL methods particularly benefit groups of students who are often under-served by traditionally taught college mathematics courses. Overall, IBL

students reported higher gains than their non-IBL peers on both cognitive and affective survey measures. For example, IBL students reported higher gains in understanding concepts, mathematical thinking, confidence in doing and communicating about mathematics, persistence, and positive attitudes about mathematics learning. Moreover, IBL students maintained their high motivation and increased their interest in college mathematics; whereas non-IBL students' motivation to graduate in mathematics clearly dropped during a traditional mathematics course. It appeared that lower achieving students' cognitive gains were higher in IBL courses overall, and while IBL methods benefitted all types of students, the learning gains were greater for IBL students who started with lower scores. In sum, the study results indicate that previously low-scoring students benefit in achievement through IBL and/or problem based Learning (PBL) while high-scoring students experience a boost in interest and motivation (Hassi et al., 2010).

Mathematics and Cooperative Learning

Cooperative learning is the use of similar groups of students working together to maximize each other's learning as well as their own (Vaughan, 2002). This learning focuses on academic and social development and the instructional processes used in cooperative learning can range from simple to complex (Lopata, Miller & Miller, 2003). In order to create an environment in which students can communicate their mathematical thinking clearly and coherently to others and solidify a role for cooperative learning in the classroom, the National Council for Teachers of Mathematics (2000) suggests creating instructional programs and techniques for that purpose. The collaborative nature of these programs and techniques allows students a

chance to complete tasks and attain concepts they may not have been able to accomplish by themselves (Paradis & Peverly, 2003).

The benefits of cooperative learning parallel Vygotsky's (1978) *zone of proximal development*, which mediates what learners can do on their own versus what they can do with help from others. Vygotsky (1978) states that adults (teachers and parents) or peers may help student development and that teachers' use of cooperative learning increases the understanding of mathematics by students of all cultural backgrounds.

Underrepresented minority students have been specifically shown to thrive in a cooperative learning environment. In a cluster experiment at the University of Texas at El Paso, students ultimately credited their success to the cluster program and its encouragement of learning communities (Fredricksen, 1998). In terms of learning style and classroom pedagogy, the racially heterogeneous clusters of twenty-five students who were followed in the experiment moved together from class to class and were taught using collaboration and community building. Team members met at least once a day to initiate discussions and work on projects for which they received both individual and group grades. "This requires the team to work until every member has mastery and satisfies the most basic assumption of cooperative learning: "the idea that students work together to learn and are responsible for their teammates' learning, as well as their own"" (Slavin, 1990, p. 3). When this type of learning occurs, we move towards constructivist models of knowledge building, where knowledge starts to become more internal to the learner.

Mathematics and Building Relationships with Students

Building and maintaining strong relationships is a key factor in the success of underrepresented students, especially in STEM fields. Positive student-faculty interactions have long been associated with positive outcomes for students, including increased effort, greater student engagement, a higher level of content acquisition (Pascarella and Terenzini 2005), and a greater likelihood of persistence and subsequent college completion (Hoffman, 2014). Rather than regarding the teacher as the arbiter of knowledge, the faculty member must be seen as a facilitator and participant in equal parts in the acquisition of knowledge (McEwan, 2011). Creasy, Jarvis, and Knapick noted that “connected relationships between students and faculty in the classroom have been closely associated with positive achievement attitudes, including student self-efficacy and student satisfaction” (2009).

Willie, Grady, and Hope (1991, p. 78) agree that the student-faculty interaction is necessary for academic success by stating that “the presence of a faculty mentor or a faculty sponsor offers the student many advantages, both personal and academic. Access to an established scholar provides the student with opportunities to test new hypotheses and research plans, affording the student a decided edge in his or her development as a bona fide scholar.” Strong instructor-student relationships are critical in the development and success of students throughout their coursework. A frequently cited explanation for the poor mathematics performance of African-Americans is a lack of appropriate role models or mentors (Marrett, 1987).

Peer relationships also have a positive effect on the academic achievement of minority students. In *The Mathematics Workshop* program at the University of

California Berkeley, each student is not only given an extensive and appropriate academic plan upon entering freshman year, but all freshmen are also introduced to upperclassmen mentors who check in and monitor their progress. In the program's second year of operation, African-American students consistently out-performed their non-program counterparts in mathematics (Treisman, 1992). The Workshop Program is now recognized as one of the most widely successful intervention programs in college mathematics and has since evolved into the Emerging Scholars Program, a blueprint adapted and utilized at more than a dozen major universities across the country including Temple, Clemson, Columbia Universities, and Ithaca College (Selvin, 1992). Mentoring can and should play a beneficial role in helping to ensure students' success. One-on-one and small group mentoring programs that involve peer tutoring, linking senior students with underclassmen, and pairing faculty and students, have all been successful; these positive outcomes have been seen in programs such as TexPrep, Bridges to the Future, and the Math, Engineering & Science Achievement programs (Estrella Mountain Community College, 2002).

Variables to Impede Minority Student Success

There are many variables that can impede minority student success. The most frequently found variables are discussed here.

Racism and Discrimination

Incidents of ethnic and racial discrimination are still prevalent in American universities (Chang, 2000; Pettigrew, 1998); African-American students in particular are more likely than white students to be the target of some form of racism in and out of the classroom (Ancis, et al., 2000; Chang, 2000; Gossett et al., 1998; McCormack,

1995, 1998; and Phenice & Griffore, 1994). Typically, the perpetrators of these incidents are fellow students; however, faculty members, campus police, teaching assistants, administrators, and staff also engage in racist/discriminatory behavior (Suarez-Balcazar et al., 2009). The most common form of discrimination is typically verbal harassment in the form of racial slurs, followed by exclusion from activities, and physical violence (McCormack, 1998). Results from the McCormack study indicated that African-Americans and Hispanics were more likely to experience incidents of discrimination than Asian students. These experiences have negative consequences on minority students' ability to adjust and persist in school. Minority students might feel alienated (Oliver, Rodriguez, & Michelson, 1985), intimidated (Freeman, 1997), segregated, (Gosset et al., 1998), isolated, and out of place at predominately white institutions (PWI) (Turner, 1994).

Suarez-Balcazar, et al., stated that “concerning the sources and environments conducive to discrimination, minority students reported that faculty and other students often constitute the primary perpetrators of such acts, whereas campuses are the contests par excellence” (2009, p. 4). While the institution itself is seen as a neutral environment in terms of heinous action, it is in fact its citizens who are the polarizing factors. As interactions between faculty and students are a fundamental component to student success, lack of these opportunities puts minority students at a disadvantage. Seyfried (1998) posited that “it is the quality of the student-teacher interaction that contributes to the students' reality of the classroom experience” (p. 387). In other words, the establishment of strong interpersonal relationships between the student and instructor contributes to how students perceive the classroom climate,

and can also affect student success. As students learn what is expected from them through these interactions, differential treatment may or may not exert a negative impact on minority student performance (Parr, 1999).

Stereotype Threat

The most definitive explanation of stereotype threat comes from Steele & Aronson (1998), which explains it as the risk of confirming negative stereotypes about an individual's racial, ethnic, gender, or cultural group. The anxiety of knowing that one can be a potential target of prejudice and stereotyping has been widely discussed in the literature. In his treatment of *racial vulnerability*, Shelby Steele (1990) makes a connection between experiences of prejudices in the school lives of African-Americans. He argued that "after a lifetime of exposure to society's negative images of their ability, these students are likely to internalize an 'inferiority anxiety' – a state that can be aroused by a variety of race-related cues in the environment" (Aronson, 2004, p. 798). This anxiety may lead students to connect to other factors for racism (for example, institutionalized racism and forming a victim's identity). This phenomenon often translates into poor success in life overall.

Stereotype threat can undermine academic achievement by interfering with performance on mental tasks by increasing blood pressure (Blascovich et al., 2001) and reducing working memory capacity (Schmader and Johns, 2003). Students then defend or preserve their self-esteem by disengaging from the subject in question (Steele & Aronson 1998). African-Americans are perhaps the most marginalized racial group on American college campuses and are especially susceptible to negative stereotypes. "In a study of undergraduates at an Ivy League university, Torres and

Charles (2004) found that white students consistently held racial stereotypes of African-Americans as unqualified for the University, able to attend only because of affirmative action quotas or athletic ability” (Beasley & Fischer, 2012, p. 431). These types of negative attitudes may also arise in white students at predominately white institutions.

The work of Steele and Aronson (1995) revealed how racial stereotypes may interfere with African-American students’ ability to achieve high test scores on standardized examinations. When African-American students were prompted to indicate their race before taking the Graduate Requirement Exam (GRE), their scores were lower than when they were not prompted to do so. This phenomenon could be explained as stereotype threat. In these high-stakes testing situations, African-American students were reminded of stereotypes that they are intellectually inferior to whites; as a result, their performance declined (Steele & Aronson, 1995).

While past research has relied primarily on the academic deficits and lower socioeconomic status of certain ethnic minorities and women to explain their absence in STEM fields, more current research has shifted focus on the impact of stereotype threat. In a study conducted by Beasley and Fischer (2012), results indicated that minorities experience stereotype threat more strongly than whites, which has a direct impact on the likelihood of both minorities and women leaving STEM majors. This may explain the dearth of certain minority STEM professionals in the United States, as it is virtually impossible to enter a STEM career without having a degree in the field.

Microaggressions

The term “Microaggressions” can be defined as brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults towards people of color. Additionally, Davis (1989) defined racial microaggressions as “stunning, automatic acts of disregard that stem from unconscious attitudes of white superiority that constitute a verification of black inferiority” (p. 1576). Examples include “averted gazes, exasperated looks” (Delgado & Stefancic, 2001), code words such as “quotas” or “affirmative action,” and comments such as, “You’re not like the rest of them” or “I don’t think of you as Mexican” (Solorzano, 1998). Pierce (1995) states that, “in and of itself a microaggression may seem harmless, but the cumulative burden of a lifetime of microaggressions can theoretically contribute to diminished mortality, augmented morbidity, and flattened confidence” (p. 281).

Microaggressions are powerful because despite perhaps being invisible or “color neutral” to the perpetrator they exact a toll on the recipient’s psyche (McCabe, 2009).

In a study published in 2000 on racial microaggressions and the undergraduate experience, many African-American students spoke of feeling “invisible” within the classroom setting. Students in the study reported that their experiences as African-Americans were often omitted, distorted, and stereotyped in their course curriculum. African-American students in the study provided examples of microaggressions in other academic settings; specifically, faculty-student interactions when faculty maintained low expectations of them (even in the face of contradictory evidence).

Another example of a student's experience was described by Solorzano: "...I was doing really well in the class, like math is one of my strong suits...We took a first quiz...and I got like a 95...he [the professor] was like, "Come into my office. We need to talk," and I was like, "Okay" I just really knew I was gonna be [told], "great job," but he [said], "We think you've cheated. We just don't know so we think we're gonna make you [take the exam] again," ...And [then] I took it with just the GSI [graduate student instructor] in the room, and just myself, and I got a 98 on the exam" (2000, p. 67). It is clear in this example that this student was perceived and stereotyped as being "less than" his peers because of his race, despite his obvious mathematical strengths.

The Solorzano study (2000) revealed that students recognize that being stereotyped carries very real consequences beyond personally feeling bad about oneself. Even "looking like" a person of color can be a cause for white professors, students, and college staff to draw negative assumptions about minority students and immediately lower expectations of them.

Isolation

Qualitative data within the literature suggest that finding a positive level of comfort on a college campus is a key factor in the academic success of minority students. The research is consistent in claims that a student will remain matriculated when he or she feels connected, involved, and served by the campus community (Tinto, 1987). However, many studies also indicate that minority students do not find an adequate level of comfort at PWIs. Daniels (1991) study quoted one participant, stating, "we feel that we're a guest in someone else's house, that we can never relax

and put our feet up on the table” (p. 5). This uncovers a feeling of being an outsider at a place where there should be a sense of community in learning and scholarship.

Much of the research focused on African-American students at PWIs overwhelmingly relates stories of academic difficulty (Fleming 1988; Nettles, 1988; Mow & Nettles, 1990, Allen, 1992), and a disproportionate, distorted image of African-American underachievement, which may be tied to the faculty’s perceived lower expectations.

While finding a level of comfort and adjustment to higher education are common problems for all college students, some of these problems are unique to underrepresented racial minorities, specifically African-Americans (Allen, 1986; Thomas, 1984). For example, African-American students often find it necessary to create their own social and cultural networks in order to remedy their exclusion from the wider, majority-oriented university community. Of all problems faced by African-American students at PWIs, those arising from isolation, alienation, and lack of support seem to be the most serious (Allen 1985, 196; Smith & Allen, 1984).

This lack of support and indifference is believed by some scholars to contribute to African-American students’ perception that racism is at the root of every problem they experience on a predominately white campus, a view through a decidedly racial filter. Jacqueline Fleming, author of *Blacks in College*, states that this may lead to a “sense of overkill,” indifference, and simple ignorance of racism in the wider society, and may be the “biggest problem” in dealing with racial tensions that arise. Students of the majority have been taught, systematically, to ignore race as a subject. What makes this indifference troublesome is that when a racial incident occurs and only a few white students on a campus speak out against it, the minority

students view the other white students as condoning the incident. This gives the impression to minority students that they do not have the support of the majority. Situations like these cause racial tensions between majority and minority students where the feelings of isolation worsen among minority students (Magner, 1989).

Summary of the Literature

Inquiry-based learning (IBL) refers to any pedagogy that replaces traditional lectures and textbooks with some form of student-centered activities. IBL appears to be more effective than traditional instructional methods at improving academic achievement (Prince & Felder, 2007). Research studies have indicated that IBL methods particularly benefit underrepresented groups (Laursen, Hassi, Kogan, Hunter, & Weston (2011). Cooperative learning is an educational approach that aims to organize classroom activities into academic and social learning experiences (Slavin, 1990). Esmonde (2009) asserts that mathematics education and cooperative learning suggest ways for teachers to assist students in cooperative groups by providing equitable opportunities for learning. Building and maintaining strong relationships is a key factor in the success of underrepresented students, especially in STEM fields. These instructional approaches were targeted in this review of the literature as a means to develop lenses through which to interpret minority students' instructional preferences and experiences in the mathematics classroom.

Underrepresented minorities between 18 and 24 account for 34% of the population but earn only 12% of all undergraduate degrees in STEM fields (Staff Writers, 2012). These students can face unique sociocultural challenges in campus learning environments, including feelings of isolation, racism, discrimination, and

microaggressions. Stereotype threat has also proven to have a negative effect on academic performance by interfering with mental tasks. These factors can lead to URM students feeling that there is a lack of support for them in learning environments, and ultimately lead to their academic failure.

Chapter 2

METHODS

Critical Race Theory (CRT) and Social Cognitive Theory (SCT) serve as foundations to this study, especially Bell's (Delgado & Stefancic, 2001) assertion that the white majority allows the advancement of persons of color when it serves their self-interest, contextualizing the underpinnings of this perception in education. CRT posits solutions based on a critical examination of society and culture (especially the intersection of race, law and power), and is used to shed light on the lack of creditability of accepted beliefs and practices held by the majority about the minority that racism is "normal" rather than aberrational (DeCuir, 2004). Using CRT in the data analysis for this study is appropriate because it examines the issue of differential success between two diverse groups as one of educational inequity.

SCT emphasizes that learning occurs in a social context and that much of what is learned is gained through observation; it has been applied extensively by researchers to assess classroom motivation, learning, and achievement (Pajares, 1996; Shunk & Zimmerman, 1994; 1998). One basic tenet of SCT is that classroom learning is shaped by factors within the academic environment, especially the reinforcement experienced by each individual and others. At the same time, learning is affected by a student's own thoughts and beliefs, as well as, their interpretation of the classroom context. The utility of SCT in the analysis is also appropriate because part of the purpose of this study is to examine the experiences of underrepresented students in the classroom in terms of their mathematical achievement.

Methodology

This chapter begins with a brief reminder of the purpose of the project, followed by a description of the qualitative research methodology used in the project. Next, the selection of the participants is examined, explaining the difficulties experienced in identifying participants. The data collection and analysis techniques related to the study are then reviewed. Issues germane to my subjectivity and those related to validity, reliability, and ethics are then addressed. The chapter concludes with a brief summary of the methodological approach used in the study.

Qualitative research methodology was employed throughout the duration of this executive position paper study. When applying qualitative research, practitioners expose themselves to considering non-standard terminologies and methodologies to complete the research process (Bogdan & Bilken, 2007). Within qualitative research, “the researcher’s primary goal is to add knowledge, not to pass judgment on a setting” (p. 38). That said, this investigation adds to the information base that interrogates the educational experiences of underrepresented students, particularly in college mathematics, without adding critical assumptions to the narratives.

In addition, qualitative research is consistent with the theoretical frameworks of CRT, and SCT. The use of voice through narratives and storytelling is common among both critical race theorists and qualitative researchers (Bogdan & Bilken, 2007). CRT allows for the unpacking of implicit instances of racism that participants may not have even noticed themselves due to being so entrenched in the situation. SCT has been applied extensively by those interested in understanding classroom motivation, learning, and achievement (Pajares, 1996; Schunk & Zimmerman, 1994;

1998). The stories told in this study regarding the participants' experiences in mathematics as underrepresented students seek to bring the unique challenges they face to the forefront. These narratives challenge existing notions of race and promote social change (Parker, 1998).

Under this umbrella of qualitative research, the investigator conducted interviews. The qualitative research interview seeks to describe the meaning of central themes in the world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say (Kvale & Brinkman, 2009). Interviews are particularly useful for getting the story that explains a participant's experiences. As suggested by McNamara (1999), the interviews conducted in this study serve as investigative follow-up after respondents complete a qualitative questionnaire. A standardized, open-ended interview approach was then used, where the same open-ended questions were asked of all of the participants. This approach facilitates more efficient interviews that can be better analyzed and compared. The interview protocol can be found in Appendix B of the executive position paper.

This study relies on self-reported data. Some researchers reject the use of self-reported data due to its alleged poor quality. However, Chan (2009) argued that the so-called poor quality of self-reported data is not always the case. Driven by social desirability, respondents might provide the researchers with inaccurate data on some occasions, but it does not happen all the time. For example, it is unlikely that the respondents would lie about their demographics, such as gender and ethnicity. Second, while it is true that respondents tend to fake their answers in experimental studies, this issue is less serious in measures used in field studies and naturalistic

settings. Further, there are numerous well-established self-reported measures of different psychological constructs, which have obtained construct validity evidence through both convergent and discriminant validation, such as Big-five personality traits, proactive personality, affectivity disposition, self-efficacy, goal orientations, perceived organizational support, and many others.

Participant Selection

Survey participants were selected for this investigation based on the following criteria:

- Enrollment in the University of Delaware's introductory Calculus courses: MATH 221 or MATH 241
- Age 18 or older

To identify potential participants for this study, the investigator initially contacted the professors of the targeted calculus courses and asked to make a short presentation to their students. The purpose of these class visits was to elicit a higher response rate when the survey was sent to the participants via email. Once the investigator began to receive responses, preliminary analysis was performed to seek out potential interview participants. By the close of the survey period (fifteen days), there were sixteen viable participants who fit the initial criteria, surpassing the survey response target.

Seven interview participants volunteered for this investigation. Initially, the criteria for the participant selection included:

- Self-identify as an underrepresented student (African-American, Hispanic/Latin@, Mixed Race, Pacific Islander, or Native American)

- Completed the Calculus Course – Student Attitudes Survey online

This criterion was largely in part due to UD's definition of who is considered underrepresented on campus. However, after preliminary survey analysis, interview participants were expanded to include those who may have experienced racially based discrimination(s) in the classroom, including Asian American and International students.

Bogdan and Bilken (2007) suggest that qualitative researchers select participants with whom they have little or no prior experiences. Glesne (2006) adds that if researchers conduct research with participants with whom they have prior relationships, failure to notice unique aspects about the participants may occur. The investigator for this study had little to no prior relationships with any of the participants.

To establish contact with potential candidates who fit the initial criteria, the investigator sent individual email solicitations to the possible participants. Unfortunately, the initial response rate was only 25%. After members of the investigator's committee posited that the compensation rate of a \$10 gift card was too low, the investigator doubled it and stressed the need for participation in the boilerplate of the solicitation email, resulting in three more individuals agreeing to participate. Seven interview participants agreed to complete the interview process from start to finish.

Data Collection

Data collection took place in April 2015. At the outset, the investigator gained permission from the survey participants for the study by obtaining electronic

signatures on the consent form approved by UD's Institutional Review Board (see Appendix C). To streamline this process, the consent form was attached electronically to the survey, and participants received an electronic copy for their records once the survey was closed for analysis. The survey, developed through an extensive review of the literature, consisted of nine sections with two free-response questions:

Demographics, Self-Efficacy, Faculty Interaction, Academic Integration, Psychosocial Integration, Content Delivery Preferences, Classroom Climate, Critical Success Factors, and Pedagogical Supports. The survey instrument used in this study, delivered through the Qualtrics survey system, is located in Appendix A.

The survey was designed to identify the current experiences of students in the classroom, and whether or not they were desirable or not desirable in terms of both overall climate and pedagogy. In order to tie this to the literature review, students were asked whether or not they had experienced instructional approaches identified in the literature as a benefit to minority learners. In the same vein, the students were asked if they had experienced factors that would impede their success, such as isolation or microaggressions within learning settings.

Interview participants were recruited via email based on the initial criteria discussed in the *Participant Selection* section. Research conducted by Stinson (2008) and in-depth discussions with my doctoral committee influenced the development of the interview protocol (found in Appendix B). In total, seven interviews were conducted; each interview lasted between 17 and 35 minutes and was digitally recorded, transcribed and coded. The researcher chose interviewing as a data collection method because it aligns with both CRT and SCT by giving voice through

storytelling to those in marginalized groups who have been silenced (Delgado, 1998; Dixson & Rosseau, 2005; Taylor, 1999) and gaining a better understanding of their motivation, learning, and achievement (Pajares, 1996; Schunk & Zimmerman, 1994; 1998). Additionally, interviews encouraged the participants to reflect on and reconstruct their mathematical experiences in their own words.

Data Analysis

The survey was administered online via the Qualtrics platform. From there, descriptive statistical data were generated through the program and tabulated either directly through Qualtrics or imported into Microsoft Excel. Responses were reviewed for frequency and percentage in order to learn what might discourage students to enroll in the introductory calculus course. The higher the frequency/percent of a response, the more the investigator took that response into consideration for developing recommendations and conclusions. For instance, the first key question (what kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes) is aligned to the survey question, *being taught in a collaborative, group-work format is critical to my success in my math course*.

In the analysis of the survey, the investigator's goal was to keep the research questions at the heart of the process. The data were organized using a three step process:

- Identify the research question
- Identify the survey question(s) that would help answer the research question

- Plan how to use the data from the survey question(s) in order to answer the research question

When analyzing the interview data, qualitative research must provide descriptions of the research study, search for patterns in the data, articulate explanations for different phenomena, create hypotheses, and sometimes cultivate theories (Glesne, 2006). Before describing the analysis of the data, the investigator provides a description for each case study. From that analysis, the investigator searched for similarities within each case. Analytic coding was employed to analyze the data (Glesne, 2006). Coding categories emerged: CRT was relevant in the analysis as I was looking for the following factors – *microaggressions*, *stereotype threat*, and *educational inequity*. SCT was relevant in the analysis as I was looking for the following factors – *self-efficacy*, *modeling*, and *social learning*. Silverman (2001) mentions that small amounts of text may be coded and analyzed very differently. This investigator experienced this while coding because it was found that some codes overlap and some are open to several interpretations, etc. Nevertheless, Silverman reminds qualitative researchers that we should not expect to place everything in a perfect category, as the idea of ‘completeness’ may itself be an illusion. This investigator learned firsthand from coding the data that there was no idea of completeness; rather, the data were coded and categorized according to the investigator’s analytical lenses at the time of the coding process.

Validity, Reliability, and Ethics

Qualitative researchers are presented with issues regarding validity, reliability, and ethics due to the nature of their research (Merriam, 1998). Merriam states that

“all research is concerned with producing valid and reliable knowledge in an ethical manner” (1998, p. 198). Throughout the course of this investigation, especially during the interview process, the investigator sought to provide valid and reliable information. This section provides a brief synopsis of the aforementioned domains and how each was addressed in this EPP.

In general, validity is an indication of whether research is sound. More specifically, validity applies to both the design and the methods of that research. Validity in data collection means that findings truly represent the phenomenon measured. In other words, valid claims are solid claims. Each interview was reviewed and interpreted by the investigator based on the interviewee’s shared experiences.

According to Seliger and Shohamy (1989), “Findings can be said to be internally invalid because they may have been affected by factors other than those thought to have caused them, or because the interpretation of the data by the researcher is not clearly supportable” (p. 95). Flaws within the study itself affect the internal validity, such as not controlling some of the major variables or problems with the research instrument. In this case, internal validity may have been compromised due to the length of the survey instrument.

External validity is the extent to which the researcher can generalize findings to a larger group or other contexts. According to Seliger and Shohamy “findings can be said to be externally invalid because [they] cannot be extended or applied to contexts outside those in which the research took place” (1989, p. 95). For example, one threat to external validity in this investigation would be that the majority of the interview participants were female.

To address issues of validity, the investigator triangulated the data to validate findings. With triangulation, research findings are usually viewed as trustworthy. Merriam states “especially in terms of using multiple methods of data collection and analysis, triangulation strengthens reliability as well as internal validity” (1998, p. 207). Thus, triangulating the interview and survey data corroborated the findings and aided in addressing both validity and reliability.

Reliability pertains to “whether the results are consistent with the data collected” (Merriam, 1998, p. 206). Its goal is to minimize the errors and the potential biases in a study (Yin, 2003). Reliability ensures that research findings can be replicated across studies (Merriam, 1998), and, refers to whether the results from the data obtained make sense.

Merriam (1998) asserts that qualitative researchers should explain the theoretical orientation of their study, the criteria and descriptions of the participants, and the context from which the data were collected to address issues related to reliability (p. 207). Following this advice, Critical Race Theory (CRT) and Social Cognitive Theory (SCT) were the theoretical framework used to guide this investigation.

Ethics refers to whether or not the research was conducted in an ethical manner. Regarding qualitative research, these issues include the protection of subjects from harm, the notion of informed consent, the right to privacy, and the issue of deception (Merriam, 1998). Ethical issues can also surface during data collection. While not foreseen as a potential harm to the study, the investigator addressed ethical issues by ensuring that the participants were aware of possible discomforts or triggers

associated with the study. Interview participants' identities were protected by assigning codes to each student during data collection.

Chapter 3

PARTICIPANT PROFILES

Borrowing structure from Merriam's (1998) analysis of multiple case study research, the investigator presents each participant with his or her own interview in the first section. Each interview is divided into the following format: an introductory vignette, college success in mathematics, interpersonal relationships with university personnel, microaggressions within mathematics settings (if applicable), and suggestions for program improvement. Drawing upon the participants' voices regularly, in their own words, the investigator will offer a cross-case analysis discussion as applicable. The data is then aligned with relevant research literature. Each participant's narrative ranged from 17 to 36 minutes; the shortest of the narratives came from a successful student, and the longest came from a student who reported feelings of isolation. Most participants were originally from the East Coast; however, one participant was from Nevada.

In total, there were seven interview participants. One participant was male, the remaining female. All participants were either in their freshman or sophomore year of college and none of them were mathematical science majors.

Student 1

A native Delawarean, Student 1 selected UD due to its proximity to his hometown and the low cost of tuition. Originally an actuarial science major, he quickly switched to "undeclared" after the realization that the major was so math intensive: "I'm not really a very, like, that strong of a math student." A freshman with a high level of sports interest, he hopes to switch into an exercise science major later

on in his academic career. Student 1 describes himself as a passive, repetitious learner of mathematics; however, mathematics does not come easy to him by any means.

Interviewer: And you also used the word passive. Can you talk a little bit about that? Why did you use the word passive?

Student 1: Mostly because...all right, so first semester I was in MATH 241 which is like the engineering math; it's like extra hard. And I like really tried when I went into that, I'm going to try as hard as I can to do well and study every night and yada yada... But it turned out I tried doing that, and I would get to a problem in the homework, and I would get stuck on it. And I would try different solutions and get stuck and stuck and stuck. And I would go to get help from my friends, and they'd be like "Huh, this is a really hard problem!" And they wouldn't even know either and I'd be on this problem for two or three hours...So yeah, so then I realized that was happening a lot. And then I declined in class. I stopped studying, stopped doing the homework first semester. When I did that I got a really low grade first semester, which is why I stepped down to 221 this semester. So "passive" basically means basically means it's the class I focused the least on. But it was a class required for my major so...

Interviewer: Gotta do what you gotta do.

Student 1: Gotta do what you gotta do.

However, despite his overall negative attitudes towards mathematics (as iterated in the Data Analysis section), Student 1 recognized the importance of success in college mathematics for a successful future.

Interviewer: Okay, I understand. What are your current attitudes towards mathematics? And you've kind of touched upon that a little bit.

Student 1: I have, well, mathematics, um, it's very useful, very, very useful. I feel like if you're very good at math, if you like math, even if you're not good at math, if you like math and you try hard to do well in it you have a better chance in the future at securing a job that you like. With math comes confidence in other subjects. Maybe that's just me but I read an article about that, kids in middle and high school who are good at math may be not good at other things like English. Math is like the pinnacle of education, I don't know. Um.

Despite these attitudes, Student 1 did not feel successful in college mathematics; in fact, he felt the exact opposite. While he was a hard working math

student at the middle and early high school level, he describes an attitude that became “lackadaisical” towards mathematics as he progressed throughout the secondary level. By the time he reached college, he describes a learning “plateau” in his math education, partially due to his attitudes towards mathematics in general. “But I don't like it at all. It's like it's come to a point where...I've come to a point where I've plateaued in my math education. And I can't, like, I probably could if I tried harder, but I just don't want to. I just hate math so much.” As we will see later, a strong relationship lies between attitudes towards mathematics and overall success in the subject.

Student 1 describes a very active and engaging professor as one who tries to get students involved during class in a meaningful way and does not spend the entire class time lecturing. Instead, the professor *checks in* with students one-on-one to ensure that they are completing problems and understanding course concepts. Overall, their relationship is cordial, and the professor motivates him to attend class, despite his attitudes towards mathematics.

Interviewer: Can you describe the mathematics classroom climate that you are currently in?

Student 1: Um, right now I'm with a teacher, she is pretty good at portraying concepts to people in class, she's a nice teacher... But she does make an effort to like walk around and when she asks a question in class she expects you to work on it and she walk around and see if you're doing it and she'll come up to you and see what you're doing.

Interviewer: How do you think that she, if at all, affects your success in the course?

Student 1: I think positively. I feel bad for not going to her class.

The relationship with the teaching assistant, however, is far from a positive one, and is more of a reflection of Student 1's negative attitude towards mathematics

as seen in by the statement "...we have a TA, or a grad student or something, and he is very sarcastic, and I'm not the only one who thinks this. We all agreed that he seems like he doesn't like his job, and he doesn't want to be there. He always walks in and sighs. He seems like he doesn't want to be there." Student 1 describes a very negative learning environment where students are not encouraged to ask questions or engage with the Teaching Assistant (TA) in any way. Simply put, the teaching assistant is prohibitive of learning within this particular discussion section. As the purpose of the discussion sections within the calculus sequence are to have material covered in the lecture portion of the course clarified, this seems to be the most daunting challenge for this particular student to overcome. Student 1 offered a troubling story of an experience of stereotype threat perpetrated by his teaching assistant, in which the TA made him feel "stupid" for asking questions in the classroom:

Interviewer: So on the survey there was a question about the discussion section. And you reported feeling kind of isolated in your discussion section. Can you speak a little bit more about that?

Student 1: And like one time this girl was raising her hand, and he [teaching assistant] turned around and was like "yes" with an attitude which would make you not want to ask a question in a first place. You don't want to be a thorn in someone's side.

Interviewer: You don't want to be that guy.

Student 1: Exactly. You don't want to feel stupid. You don't want to be asking questions all the time.

Student 1, once a high achiever in mathematics did not want to be perceived as underachieving or "stupid"; these feelings could mitigate stereotype threat in the individual based on the stereotype that African Americans are less intelligent than other groups (Steele, 1995). If negative stereotypes are present regarding a specific

group, group members are likely to become nervous about their performance, which may hinder their ability to perform. However, the individual does not need to subscribe to the stereotype for stereotype threat to be activated. Student 1 offers a variety of suggestions for calculus course program improvement, specifically for freshmen or those learners new to calculus courses.

Other suggestions for improvement included increased opportunities for grades (i.e., *counted* homework and projects to increase understanding of more difficult concepts such as optimization) and the integration of group work (Table 2). While the increased opportunities for grades may be seen as an intervention that you might implement in a post-secondary setting, the integration of group work within a calculus setting aligns with both the survey results and the findings of the literature.

Table 2 summarizes the challenges posed by Student 1 in each of the four key question domains and identifies the solutions proposed by Student 1 for meeting each of those challenges.

Table 2. Suggested solutions from Student 1

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Teaching Assistant: not inclusive or welcoming, student was made to feel stupid	Standardized training and vetting of TA's
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	Increased opportunities for grades; integration of group work
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	Supportive primary faculty member; non-supportive teaching assistant	Standardized training and vetting of TA's
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Personal negative attitudes towards mathematics	Reaching out for support from outside academic resources from the university

Student 2

A pre-med major hailing from Orange County, New York, Student 2 is a freshman enrolled in MATH 241 with dreams of becoming a missionary doctor. “I want to help people and spread the gospel,” she replies, as her faith is very important to her. This is not uncommon of African-American students, specifically women, at the college level (Lori, P. & McClure, M., 2009). The draw for Student 2 to the University (like Student 1) was financial; she received a sizeable academic

scholarship upon admission. She describes herself as a slow, analytical learner of mathematics who finds it imperative to “write everything down” that the professor recites or writes on the board for fear of missing a concept. While she doesn’t necessarily enjoy mathematics, she has found a modicum of success with the addition of a one-on-one tutor: “Calculus is crazy for me. I thought like I didn't understand it, but I got a tutor recently and I found that I do understand it, it's just that they don't teach it the way I need it to be taught.” Here, Student 2 speaks of the current format of the course – the traditional lecture model – and how it has been a detriment to her learning.

While Student 2 spoke highly of a former university mathematics professor, she does not have a relationship with her current professor; she believes this is due to the large class size. The current lecture style class is lacking the one-on-one interaction with the professor that would make her feel more comfortable asking key questions and help her to better understand the course content. “I haven’t gone to office hours, but that’s because I wouldn’t know what I’d ask to begin with if I went.” It is clear that this student would like to seek help, but does not even know where to start, nor does she want to waste anyone’s time in the process. Student 2 is also uncomfortable with the pace of the class, noting that even students who excel in mathematics find the learning curve to be fast. In addition, she claims that the professor “makes a lot of errors” when performing mathematical tasks on the board during lecture. What she is really looking for is some individual acknowledgement from her professor – “Just so I’m not another number.” Student 2 feels strongly about the expectations that her professor has put on his students in terms of foundational

mathematical knowledge, an expectation that she feels may be unreasonable for many students in the classroom.

Interviewer: What do you think your current instructor could do to better support you to succeed in your current course?

Student 2: So, yeah, there are some people in the class who didn't take that who have never seen stats -- I mean calc, who have never taken a calc class. To have that in mind, yeah.

While Student 2 was not the direct victim of racism or microaggression within a mathematics setting, she was quick to offer the story of what she believed to be a reoccurring microaggression perpetrated towards a fellow African-American female in her class.

Interviewer: Okay. Have you ever experienced discrimination, prejudice, or been the victim of microaggressions due to your race or ethnicity within a college mathematics setting? If so, could you describe what happened? How did you respond, if at all?

Student 2: Within a mathematics setting? No.

Interviewer: Within a mathematics setting not at all? Okay.

Student 2: In other settings, yes. But not in mathematics. Wait, have I witnessed it on my part like, towards only me? Or have I seen it towards other minorities in my class?

Interviewer: Have you seen it towards other minorities in your class? Would you like to speak on that?

Student 2: Yeah. Like, the girl that always kinda follows along with the professor, she's black. And she's a native Delawarean. She kind of is an inner city kinda, I dunno, she kind of has a --- she "talks black" if there's such a thing as "talking black," you know what I mean?

Interviewer: Yeah.

Student 2: She's got an inner city type of, she raps. She actually does rap. To me, she's just a normal black girl. But um, when she follows along and tells the professor, "oh, I don't think you did that right," she keeps him on check basically. When she's not there, he makes mistakes and people don't call him out on it. And other people won't catch it. But when she's there she calls him out on it. And people are able to see where he's made the mistakes. Like just,

slight things that can earn you points off on an exam. Like, instead of negative 2 you put 2, things like that. When she's calling him out, you'll see the other white kids look at each other like "why is she doing that?" in a certain way. To me, she's like, helping us.

Interviewer: Yeah.

Student 2: If she's not there, nobody's calling him out and I notice some mistakes. But when she's there, she's calling him out and then you see everyone erasing and writing the correct answer down because the professor made a mistake. And he noticed that he made a mistake because of her. And he's erasing it. I don't think they do it anymore, but initially they'd look at each other, they'd give each other looks, that's a microaggression because it was her.

Interviewer: Right, right. Was there any response to that?

Student 2: She was in the front, so she didn't see it. She was in the front looking straight at the professor. I was in the third row and I was seeing it.

There are several elements within this vignette that require unpacking. While it was more than likely unintentional (“if there’s such a thing as talking black, you know?”), Student 2 perpetrated a stereotype against the student she was speaking about in her interview. One would assume that this was due to her level of comfort with me, her black female interviewer. Indeed, within her particular narrative, and one of the key elements of critical race theory, she addresses the microaggression perpetrated against her classmate freely without the fear of repercussion from white privilege working against her.

Within the incidences themselves, these microaggressions may have occurred due to a phenomenon studied by Steele & Aronson, et al., when a majority group is placed in a “position of feeling” stereotyped by a higher performing member of an ethnic minority group (1998). Despite whites not having ingrained feelings of inferiority in mathematics, situational pressures alone – i.e., the stereotype about Asians coupled with the desire to perform well – were sufficient enough to interfere

with performance. Simply stated, the seemingly innocuous microaggression perpetrated against the African-American female student, covert and slight in nature, was a way for her white peers to reassure themselves that they were not intellectually inferior to her.

Most importantly, why was this not addressed? It could be that the action was so slight that it went unnoticed by the majority of students in the classroom. However, incidents like these cannot be ignored, as they foster a classroom culture that may lead to damaging consequences for students of color. Yet, being an underrepresented minority student in a sea of white privilege, being called upon to address racism in any setting is more than just a daunting task. Educators can counteract these types of incidents from occurring in the classroom by articulating clear expectations regarding racism, and establishing and enforcing a series of consequences for (Pollard, 1989). It is important to note also that this may not have been a racially motivated incident at all, it was perceived to be one by the student. Perhaps her fellow classmates found it peculiar that any student would call out a professor, a person in a position of power, and would therefore comment upon it.

In terms of program improvement, as was a point iterated throughout the course of the interview, Student 2 had concerns for students coming into the university with no previous exposure to calculus. Even having taken Pre-Calculus at the university level, she still felt unprepared for the rigors of Calculus I. The lecture model, standard throughout the country in calculus courses, seems ineffective for this particular type of learner, as she seeks more one-on-one interaction, a less aggressive pace, and an overall friendlier environment within the course setting. It seems as if

she would get more out of the type of setting that Student 1 is receiving, where the instructor often “checks-in” with each individual student in the classroom. Along these same lines, Student 2 addresses concerns about her professor in terms of the overall pace of the course, noting that it may be too fast, even for those who are doing well.

Interviewer: What are your current attitudes towards mathematics?

Student 2: Calculus is crazy for me. I thought like I didn't understand it but I got a tutor recently and I found that I do understand it, it's just that they don't teach it the way I need it to be taught. Like, slowly, and step-by-step. It's all just really fast and I can't keep up. It's not that I can't do it, it just not the way that I need it to be done.

Student 2: But sometimes she'll [a fellow student] just be like "I just don't understand" but she likes math actually, she's good at math, it's just the way, it's just the pace for her is just--

Interviewer: Fast?

Student 2: Fast. And he does make a lot of errors.

Student 2: But the way my tutor teaches is great. Like after every 2 [minutes] he asks, "does anyone have a question?" Then we go to the next step. If yes, then we go over it again. Then okay, now it makes sense: then we go on to the next step. Like, take a step, ask questions, then go on to the next step. Not just continuous writing, writing, asking no questions. Just writing.

As iterated in the literature review, the lecture model of calculus teaching and learning is no longer one that many minority students, including Student 2, are finding success in. Not only that, it seems that the professor is moving at a pace that is not suitable for even his more advanced students – an indication that he is not developing a relationship with his students. Again, this relates back to the survey items in regards to students feeling comfortable approaching their professors for assistance, and how that may relate to their success. More collaborative type models,

such as the cluster learning experiment at the University of Texas at El Paso, may be worth investing to reach and teach this struggling subset of students.

Table 3 summarizes the challenges posed by Student 2 in each of the four key question domains and identifies the solutions proposed by Student 2 for meeting each of those challenges.

Table 3. Challenges and suggested solutions from Student 2

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Pace of lecture; microaggressions witnessed in the classroom manifested feelings of discomfort	Differentiation of instruction to reach and teach all learners; Faculty training to identify and prevent discriminatory behaviors in the classroom
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	Integration of a calculus prep course
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	High expectations of prior mathematical knowledge	Pre-testing of students at the beginning of the semester to gauge prior knowledge and skills
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Teaching calculus in a variety of ways to reach all learners Acknowledgement from primary instructor	Looking beyond the lecture model and differentiating instruction in the classroom

Student 3

Originally the investigator sought to interview participants whom UD considered “underrepresented minority students,” and I did not include Asian American or International students. However, the results of the survey indicated that these students were the only participants who experienced differential treatment based on their race/ethnicity in a mathematics setting. With this in mind, I made a mutual decision with my committee to open the participant pool to all minority students and hopefully get an understanding of these potentially racialized phenomena within mathematics settings.

Hailing from South Jersey, Student 3 is an Asian American student enrolled in MATH 241. She chose to attend UD, simply put, because it was the lesser of two evils. A Physics major, she was drawn to the subject by a teacher in high school, and frankly, liked the fact that all of the “stupid maths” that she had to learn in high school were finally getting put to good use at the post-secondary level. She describes herself as a hardworking, resilient, and punctual mathematics student. While math is not her favorite subject, she prefers it to other subjects such as English. Because her major relies heavily on mathematics, her interest in it is fairly high, as mathematics can show and model how the world works. She is one of the few participants who were relatively confident in their success in mathematics.

Interviewer: Do you feel that you are successful in mathematics?

Student 3: I would say I'm not as successful as I'd like to be. I have a passing grade right now which is...it could be better. But I would say it would be nicer to have a higher grade not just because it's a number but because my understanding could be deeper of what we are covering.

It should be noted that Student 3 did not reveal to the Interviewer what her exact grade in the course was; only that she was “passing the course.” This was similar to all of the participants in the study.

Student 3 describes a “professional” relationship with her professor. “He knows my name; he knows who I am. I see him for office hours.” Their relationship is on a surface level, as described by Student 3, “you cannot really get to know someone by asking them questions about assigned homework problems or exams.” However, she acknowledges that her professor affects her success in a positive way:

Student 3: My professor affects my success -- it affects me in a positive way. There are notes he puts up on Sakai that he'll go over in class. He also does UD Capture and will go back and refer to it. He's always available during office hours and a lot of times before exams he'll extend his office hours. There's a lot of time available and there's a lot of things you can use to help you succeed.

Thus far her experiences with UD staff, be it professional staff or tutoring staff have been positive. The experiences of Student 3 parallel those of Student 1, who also shares a favorable relationship with his calculus professor. This supports the results from the survey that indicate that staff can play a positive role in student mathematical learning. However, when asked how, if at all, the relationships between UD Math Professors and students might be improved, Student 3 offered the following:

Student 3: Maybe understanding that although yes your course is very important and we all need it and it is a major requirement, the amount of work that is expected at any given time on a mid-term exam or something for that matter, we're not always knowing what to expect because it's written by a higher up person in the math department. So maybe just...the math department being aware that there's a lot of tough courses happening at the same time.

Unreasonable expectations of students are indicative of a lack of a relationship with them. These types of expectations were present during a later interview (Student

7). This highlights the problematic concern for a high percentage of minority students who responded on the survey that they do not feel comfortable reaching out to their instructor for assistance. Therefore, these students cannot take advantage of the value added benefits that a professor can add to their success in calculus.

Student 3 was the only participant who was the direct victim of microaggression within a college mathematics setting, not only within calculus, but also within Pre-Calculus at UD. She was willing to speak about both of these experiences, if not very nonchalantly.

Interviewer: Okay. Have you ever experienced discrimination, prejudice, or been the victim of microaggressions due to your race or ethnicity within a college mathematics setting? If so, could you describe what happened? How did you respond, if at all?

Student 3: My one friend [white male] told me "you know you're better at this because you're Asian". I said ok.

Interviewer: How did that make you feel?

Student 3: I didn't really care, because this person was one of my good friends, so I just took it lightheartedly. I know who this person is.

Interviewer: On the survey, you indicated that you felt that you had been treated differently in your mathematics classroom due to your race or ethnicity. Can you elaborate?

Student 3: Uh not necessarily the current class, is this applicable or no? I just notice in other classes that I had math, I was one of the few of my ethnicity, and people would assume I knew what I was doing.

Interviewer: Was this here at the university?

Student 3: Yeah.

Interviewer: Do you remember what level math this was?

Student 3: 117.

The irony is that her personal feelings towards her performance in class directly counter the stereotype placed on her by her white male friend and the

students in Pre-Calculus. However, this can place a different type of stereotype threat on Student 3 and other Asian American students, namely, the “model minority” effect.

In an interview by Ly (2008), Blair remarked that “with Asians, when you remind them of their ethnicity or race, you actually get an increase in performance, so we know there’s a little bit of a benefit in that stereotype in terms of ... confidence, motivation or ... that believing you really can do something or believing that other people believe you can really do well in something.” Ironically, the stereotype placed upon Student 3 seemed to have no effect on her performance in MATH 117 based on her comments above.

While many students would be satisfied with a passing grade, especially in a course as rigorous as Calculus, Student 3, as quoted above, has a desire for a stronger understanding of the mathematical concepts. Perhaps the “model minority” phenomenon is a part of the reason for that desire.

It is important to note that in both cases of microaggression examined in the interview data, issues of white privilege (one of the major themes of critical race theory) were prevalent in the possible reasons why the incidents were not addressed within the settings. White privilege refers to the social advantages, benefits, and courtesies that come with being a member of the dominant racial majority. White privilege manifests in a myriad of ways. Examples are situational and include instances such as, a clerk not following a customer around in a store to assure no thefts, or not being subject to irrational fear of majority people when one’s presence is the cause of anxiety, terror, or impending criminality (Delgado & Stefancic, 2011).

Student 3 was generally pleased with the structure and format of the calculus courses offered at the university; however, she offered one suggestion for improvement in terms of the structure and organization in the discussion sections. Her concerns lie primarily in the training of the teaching assistants:

Student 3: Well depending on your discussion section the TA can be helpful or not helpful so it would be nice if there were some continuity across the board of all the TAs where they're basically doing their own thing. I've had one TA that basically stood there and asked us if we had any questions, but none of us really did anything about it because we all had questions, but we didn't know how to approach it. And the TA was not clear at all. I had another TA though who will ask for questions but will also do example problems and have us work on problems and then see if we run into any issues. So it would be nice to see some structure in the discussion sections because I know depending on who your TA is sometimes it's just a waste of time to go.

Other interview participants provided clarity on the curriculum and pedagogy within the mathematics discussion sections; they also assessed the quality of the teaching assistants who instruct them. Results indicate that there is no relation between the instructional pedagogy and curriculum across discussion sections. As an example of this, Student 2 reported having only worked in a group setting when attending a discussion section that was not her assigned one, while her assigned discussion was more of a question and answer session with her teaching assistant as she stated, "we don't work in groups or anything. We just ask questions on what was assigned and he goes over it." This question and answer style class session revealed issues of stigma and stereotype threat for two of the participants, both of whom are African-American.

As social cognitive theory dictates that much of what is learned is through observation and environment, it would seem here that the inconsistent learning environments presented across the discussion sections could be perceived as

damaging to students. Student 3 was not the only student who addressed concerns about the quality or demeanor of teaching assistants; comments were also made by Student 1, and as we will see later, Student 5. These students mainly identified feelings of stereotype threat mitigated by their teaching assistants, albeit it intentionally or unintentionally.

Table 4 summarizes the challenges posed by Student 3 in each of the four key question domains and identifies the solutions proposed by Student 3 for meeting each of those challenges.

Table 4. Challenges and suggested solutions from Student 3

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Teaching Assistants: poorly trained, inconsistent learning environments within discussion sections Microaggressions manifested by peers	Standardized training and vetting of TA's Racism and discrimination sensitivity training of students (possibly through residence assistants)
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	None (generally pleased with the format and content of calculus courses sans discussion sections)	
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	Unreasonable expectations of students in terms of workload by primary faculty member(s)	More appropriate scheduling of workload and exam schedule for students
4. What factors have the most effect on the self-efficacy of underrepresented minority	Personal desire for deeper understanding of	Reaching out for support from outside academic resources from the university

Student 4

Student 4 is a freshman Hispanic/Latin@ participant from Las Vegas, Nevada. Her choice to attend UD was based on the strong Marine Science Program. Her interest in the subject stemmed from an experience in a biology camp during her senior year in high school in California. Enrolled in MATH 241, she describes herself as not the strongest mathematics student, though she is committed to learning the subject. “I’m committed, but it’s just a struggle to do it. You just don’t want to. For me, I don’t like *like* math, but for others it’s like ‘oh I like math’ and understand it fully, it’s not as annoying for them, but it’s hard for me to learn it.” These comments echo those of a number of the interview participants in terms of attitudes towards mathematics. As we will see later, these negative attitudes towards mathematics relate to the success (or lack thereof) in the course. Though committed to learning mathematics, she has no interest in the subject and takes it because it is required for her major. These comments sound similar to the grievances of Student 1, enrolled in calculus simply because it is a requirement.

While she does not attend office hours, mainly due to a language barrier that was described as difficult yet surmountable, she sits in the first few rows of lecture so that her professor knows her face and recognizes her outside of class. She describes their relationship as “friendly.”

Student 3 also commented on a language barrier, and some participants had a similar relationship. This interpretation of her [Student 4] relationship, viewed

through social cognitive theory, is beneficial to her learning in that her learning is affected by her own thoughts and self-beliefs (Deiner, H., Wolters, C., & Benzon, M., 2014). That said, she is comfortable asking questions during lecture, and believes their interactions to be those of a normal student-professor relationship. When asked how relationships between students and UD math professors could improve, she indicated that professors should be there to help you succeed.

Student 4 offered several suggestions for program improvement. She eagerly described an active learning experience from high school that she believed could not easily translate to the post-secondary level. However, research indicates that the integration of active learning within mathematics can bolster student learning, especially for underrepresented populations.

Student 4: During high school it was more interactive. I remember in Pre-Calc he would ask us the problems or give us an example and then he would write one on the board and then ask people to give the answer or then write it on the board. Stuff like that. And I know in lectures in college, it's completely different. You don't have time for all that stuff, but in discussions there's kind of time for that stuff. You have an hour I think in discussions.

This student in particular commented heavily upon her positive past experiences with mathematics, which happened to take place in her post-secondary schooling. As many introductory calculus students are coming directly from high school, perhaps it may be relevant to take these experiences and pedagogical practices into consideration when reflecting upon how we might make relevant changes for improvement.

Other suggestions for improvement included lengthening the time of the discussion section, integrating collaborative work within them, and modifying the types of assignments in the WebAssign program. A major complaint is that the types

of problems encountered in the WebAssign program are vastly different to those encountered in lectures and on exams.

Table 5 summarizes the challenges posed by Student 4 in each of the four key question domains and identifies the solutions proposed by Student 4 for meeting each of those challenges.

Table 5. Challenges and suggested solutions from Student 4

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Little interactivity between students and professor and student to student during class makes learning static	More engaging, active learning activities in the classroom
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	None (generally pleased with the format and content of calculus courses sans discussion sections)	
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	Unreasonable expectations of students in terms of workload by primary faculty member(s)	More appropriate scheduling of workload and exam schedule for students
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Personal desire for deeper understanding of mathematical concepts	Reaching out for support from outside academic resources from the university

Student 5

Student 5, a sophomore in biological sciences major from Southern New Jersey, suffers from a profound case of mathematics anxiety. Similar to Student 2, she described herself as a slow learner of mathematics, needing content to be broken down into steps. Enrolled in MATH 241, her attitudes towards mathematics were very clear – she doesn't like it at all. While she found some success at the secondary level in mathematics, like the student interviewed directly prior to her, specifically in algebra and calculus, she found that the rigors of collegiate level mathematics put her in a tailspin. Her lack of success is not due to a lack of trying: "I try everything; I study a lot. That's one of the classes I study the most in. I struggle so much in it. I really do neglect a lot of my classes that I should be studying for, that should be easy. But I'm just so focused and so scared of failing Calc, I just--that's what I focus on."

Mark H. Ashcraft defines math anxiety as "a feeling of tension, apprehension, or fear that interferes with math performance" (2002, p. 1). In other words, math anxiety is an inability to perform in mathematical settings despite knowledge or skill level. In the case of Student 1, this fear finds its source within the instructor: "I think it depends on the teacher, if I have a good teacher I'm okay. Like if I have a bad teacher then I have anxiety. Like some courses I had --- in algebra and calculus [in high school] I didn't have anxiety but geometry and pre-calculus I had anxiety. And it doesn't make sense because in high school I didn't have anxiety in calculus, but when I get here, like, it just kills me." As she continues, however, the source of her anxiety is less clear; what is clear is that it is truly a detriment to her success in her current course. Student 5 describes her current calculus professor as having no effect on her

success or course grade whatsoever, as she barely understands what is going on in the class in the first place. "...Once he says something that I don't understand, it's over. I just don't know. It's just like, just go home. Call my friends. My discussion teacher, he does help me: he would affect my performance more than my lecture teacher." Her frustrations with regard to her professor echo that of a number of interview participants. In addition, her remarks with regard to the teaching assistant resound with Student 3's comments in regards to the varied training and preparation of teaching assistants. In this case, the teaching assistant proved to be of help to her, while in other cases, such as in the case of Students 1 and 2, the discussion teacher was more of a detriment to their success.

In offering suggestions for improvement in the calculus sequence, unsurprisingly many of Student 5's interventions were centered on the instructor. Overall, she would like to see improved relationships between UD math professors and students, where students feel comfortable asking questions during class time and attending office hours if necessary. Currently, the classroom climate is one that is unwelcoming and does not encourage discussion:

Interviewer: Can you discuss your mathematics classroom climate?

Student 5: It's very quiet. A lot of people don't ask questions. I'm going to be honest with you: it's very silent. I feel like a lot of people are afraid to ask questions, but it could be, it's like, maybe one or two questions per class. During some class days, nobody asks a single question, and I know not everyone understood what the professor was talking about.

While it is true that she is making an assumption about her fellow peers, it is safe to say that the classroom leans towards the hostile side of the spectrum. If students are not engaging with the professor for any reason, one must ask the question why that is the case. Student 5 had more complicated reasons for not speaking out

during class. Like Student 1, she may be the victim of stereotype threat within her discussion section as well.

Interviewer: Now on the survey you reported feeling pretty isolated in your discussion section, can you speak a little bit more about that?

Student 5: Me personally I'm afraid to ask questions because I don't want to look stupid because I feel like a lot of people in my class do get the material and like, I don't get it.

Interviewer: So why do you think you're afraid to ask questions, I'm guessing that's why you feel isolated.

Student 5: Yeah. I just I guess I don't...for me, like, when I ask questions I don't want to feel like I'm, I don't want to be judged. I feel like I'm the only person who doesn't get it. I don't know why I feel that way but I just feel like I do. I feel like nobody feels like how strongly I do about math so it's just, you know...I don't know. I mean I should ask questions but...

As with Student 1, Student 5 hesitated to ask too many questions of her teaching assistant for the fear of being perceived as the underachieving, “stupid” black student. Again, stereotype threat has been shown to reduce the performance of individuals who belong to negatively stereotyped groups, such as African Americans.

Again, one core premise within the social cognitive theory is learning through observation or vicarious learning. Live demonstrations of a skill by the professor typify the notion of modeling. However, if the relational processes involving attention, retention, production, and motivation are not present during observation, students do not, as in this case, fully understand or engage with the model (Deiner, Wolters, & Benzon, 2014).

Finally, when asked how her current instructor could better support her success, Student 5 offered very powerful words on the group activity. A number of other participants, including Students 1 and 4, also spoke highly of group work as a way to support their learning in a positive way. As supported by the literature,

working in groups has been shown to support minority student success in mathematics (Vaughan, 2002; Lopata, Miller & Miller, 2003):

Student 5: I would say -- I would say have group activity. I really do believe in group activity: I really do think it works. Because, I don't know, four brains is better than one, especially if people are struggling. I would rather be with four people, and we kind of all figured it out together. If he did something like that I would feel more comfortable in the course. I just really like group work. That's my position.

This is indeed a powerful statement regarding how group work could potentially transform a struggling learner into a successful one; a statement that I believe should not be taken lightly. Based on the negative classroom environments that she has experienced, a more collaborative environment could indeed elevate her mathematical understanding, and not only that, but also decrease the level of isolation that she perceives in the classroom.

Table 6 summarizes the challenges posed by Student 5 in each of the four key question domains and identifies the solutions proposed by Student 5 for meeting each of those challenges.

Table 6. Challenges and suggested solutions from Student 5

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Mathematics anxiety Fear of asking questions	Increase level of comfort within classroom setting
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	Struggling solo learners	Integration of group activity
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	Primary faculty member – not helpful in learning Teaching assistant - helpful	More engaging faculty members (SCT concept)
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Mathematics anxiety (Perceived) isolation in the classroom	Reaching out for support from outside academic resources from the university

Student 6

Student 6 could be described as the “strong, silent type”. A multiracial (African-American and white) sophomore Biochemistry major enrolled in MATH 241, she gave little detail about her personal background or interests. She described herself as a solo learner, but one who is strong in mathematics content. Unlike many students, she is not one to just memorize formulas and move on; instead, she chooses

to comprehensively learn the content as seen in the remark “when I learn something I don't like to just memorize this formula. I like to know why it is that way.” This type of interest in mathematical understanding echoes that of Student 3, who also spoke of an interest to fully grasp concepts rather than just to learn on a surface level. While not finding any interest in the current course topic, she is generally interested in mathematics as it relates to her major, though she chose her major because it had less mathematics requirement than other scientific majors.

Student 6 is what you could consider a very self-regulated learner, one of the core concepts of social cognitive theory. SCT models of self-regulation assume that self-regulation is dependent on goal setting, in that students are thought to manage their thoughts and actions in order to reach particular outcomes (Schunk, 2001; Zimmerman, 2000). Student 6's motivated choice to comprehensively learn the content allows her to reach her goals.

In terms of the relationship with her professor, she describes it as “distant,” but not in a negative way. As a solo learner, she does not feel the need to approach him for assistance or support. “I think he's doing a good job, it's just, I mean, he's available. So if I needed him I could go to him but I don't think there's anything specifically that he could do to better support me, I just haven't taken advantage of it.” She did admit during the interview to taking advantage of office hours during her Pre-Calculus course the previous semester (MATH 117). She found this exercise to be helpful.

In terms of suggestions for program improvement, Student 6 offered none. She believes that the program is ideal as it stands and that the academic supports

outside of the lecture and discussion sections are sufficient ways to reach and teach as many students as possible.

Interviewer: Okay. What changes would you like to see or suggest in the mathematics department at UD specifically in calculus courses to better reach and teach all learners?

Student 6: Um. I don't know. I think there are a lot of different outlets already. The lecture, the discussion, the WebAssigns, if that's how you learn over and over, there's tutoring available, that's -- I think there's already a lot of different resources for all different sorts of learners.

Though she does not name it specifically, here Student 6 speaks on methods of differentiated instruction offered by the Calculus Program in an effort to communicate to a wider variety of learners.

Table 7 summarizes the challenges posed by Student 6 in each of the four key question domains and identifies the solutions proposed by Student 6 for meeting each of those challenges.

Table 7. Challenges and suggested solutions from Student 6

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	None listed	
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	None (generally pleased with the format and content of calculus courses sans discussion sections)	
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	None listed	
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Personal desire for deeper understanding of mathematical concepts	Reaching out for support from outside academic resources from the university

Student 7

A freshman North Jersey native, Student 7 chose UD because of the overall campus atmosphere and its convenient proximity to her hometown. A fashion merchandising major enrolled in MATH 221 her goal is to enter the fashion industry upon graduation. Like a few of the other participants, she describes herself as a slow learner of mathematics, one who requires practice through repetition in order to fully

understand concepts. Though a B to B- student, she describes herself as an “average, not successful” student. When asked about her attitude towards mathematics she responded, “I don’t like it. I can’t wait till calculus ends.” A rather disheartening statement, it echoes the overall attitudes towards mathematics of a number of the other interview participants.

Self-efficacy also has emerged as a prominent and influential concept within the social cognitive theory. Self-efficacy reflects individuals' beliefs about whether they can achieve a given level of success at a particular task (Bandura, 1997). Students with greater self-efficacy are more confident in their abilities to be successful when compared to their peers with lower self-efficacy. Self-efficacy has proven useful for understanding student motivation and achievement in academic contexts. Higher levels of perceived self-efficacy have been associated with greater choice, persistence, and more effective strategy use (Pajares, 1996).

Her relationships with university personnel within the mathematics department are mixed. “I really like the T.A. of the discussion section, I feel like she is very understanding and she wants to help us.” This positive review of the teaching assistant, however, does not echo some of the previous concerns held by other interview participants, though it sheds light on the comments of Student 3 in terms of the varied nature of T.A. preparedness and training. Though a self-described autonomous learner like Student 6, she speaks positively of the group work that her discussion section teaching assistant often assigns “...so when she puts us in groups it’s, like, okay because you get to learn from other people too when you’re not understanding something.” Student 7 describes a strained relationship with the

professor of her lecture class, however, “Um, the professor's a lot nicer in email than in person, so that's why I choose the email route. Like she, the instructor, is very intimidating and is very mean. And rude, and I would rather just talk to the instructor over an email than talk to her in person.”

Student 7: I don't think the instructor cares actually about how actually anyone does.

Interviewer: So you don't think she cares about your performance?

Student 7: No. I think they just want to just get through the class I guess.

Here, Student 7 very openly discusses her disappointment with her professor, with a suggestion in her tone that they simply do not care about their students.

This borderline combative attitude held by the professor is preventing their students from forming any kind of relationship, let alone approaching them for help. This, in turn, may be negatively affecting student success. As we explored in the case of Student 3, Student 7 was also faced with what she felt were unreasonable expectations held by her professor.

Interviewer: Okay, let's dive right in. Choose three words that describe yourself as a learner of mathematics.

Student 7: I guess I learn by practicing, I have to practice a lot, repetitiously. I have to do something over and over again to get the concept. I'm pretty slow, I have got a certain amount of time to learn something, I can't just learn quickly. To me I'm very detailed, so I can't just like...like the professor just can't expect us to know -- I would need a lot of detail to go along with the concepts.

Unreasonable expectations of students may be related to weak or nonexistent relationships between student and instructor. This, in turn, can negatively affect the overall success of a student.

In terms of program improvement, Student 7 is also seeking UD math professors who are more approachable and wants to feel comfortable asking questions in the classroom and in a one-on-one setting. Though she was unsure of its feasibility, class size was an issue for her, as she would feel more comfortable in smaller group settings. Working in collaborative groups had been iterated by a number of the interview participants, and also, noted in the literature review as being a successful way to bolster the success of underperforming students (Vaughan, 2002; Lopata, Miller & Miller, 2003). Finally, more opportunity for grades, such as counting the homework assignments towards the final grade in the class, was a suggestion to assist other learners to succeed.

Table 8 summarizes the challenges posed by Student 7 in each of the four key question domains and identifies the solutions proposed by Student 7 for meeting each of those challenges.

Table 8. Challenges and suggested solutions from Student 7

Key Question	Challenge	Solution(s)
1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?	Slow, repetitious learner of mathematics	Pace and differentiation of instruction
2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?	Feasibility of working in small group settings	Collaborative work in discussion sections
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?	Unreasonable expectations of students in terms of prior knowledge by primary faculty member(s)	Comprehensive pre-testing of students to fully assess prior knowledge and skills
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?	Desire for autonomy of learning	Working collaboratively – leading discussions

Interview Discussion

The results of the interview revealed the following major themes within the exploration of access to mathematics, academic achievement (success in mathematics), and race and/or racism:

- 1.) Interpersonal Relationships with Instructional Staff and Students
 - a. Microaggressions within Mathematics Settings
- 2.) Issues with Instructional Delivery Methods

a. Desire for Collaborative Work in the Classroom

3.) Self-Efficacy/Self Perception of Mathematics Achievement

Despite interview participant negative attitudes about the mathematics in general, it should be noted that Student 4 had generally positive feelings about both her current professor and teaching assistant. However, three of the five participants with negative attitudes regarding mathematics shared negative views of their current professor. In addition, concerns about unreasonable expectations, instructor pacing, and negative attitudes were revealed within the interviews. One of the core concepts of social cognitive theory is observational learning through modeling and this process is inhibited, specifically motivation to learn, when a student cannot connect with their professor. The study research demonstrates that positive attitudes towards mathematics relate to success in mathematics.

Several students, either directly or indirectly, were the victims of microaggression or stereotype threat within mathematics settings. Whether it was a matter of being made to feel inferior, or being placed on a pedestal, these types of interactions are important in the analysis of the minority student experience within mathematics settings. In the cases of two students, these feelings caused a sense of isolation within the learning setting, and seemed to have directly affected their overall success in the course. Table 9 shows the relationship between the participants' attitudes towards mathematics and their self-perceived success based on information from their profiles.

Table 9. Participant profiles

Participant Profiles			
Participant ID	Course	Success in Math	Math Attitudes
Student 1	MATH 221	Unsuccessful	Negative
Student 2	MATH 241	Unsuccessful	Negative
Student 3	MATH 241	Successful	Positive
Student 4	MATH 241	Successful	Negative
Student 5	MATH 241	Unsuccessful	Negative
Student 6	MATH 241	Successful	Positive
Student 7	MATH 221	Unsuccessful	Negative

As Table 9 shows, the students interviewed in this study who succeed in math tend to have a positive attitude towards mathematics. A negative attitude leads to poor success in mathematics while a positive attitude leads to higher success.

The findings of this investigation indicate the differential success of seven ethnic minority students in college calculus. As their stories suggest, their experiences in mathematics and, in some cases, as minority students were unique. The data suggest that there are implications for further research, policy, and practice.

This investigation attempts to expand the literature regarding the understanding of mathematics experiences of underrepresented students in calculus courses. Moreover, it attempts to offer a discourse on success as it pertains to the experiences of underrepresented minority students, specifically African-American and Hispanic/Latin@ students. While this research has the potential to extend the view concerning the obstacles that underrepresented students face, my hope is that those vested in their mathematics education will affect positive strategies for implementation in their domains to provide URM students (specifically African-American and Hispanic/Latin@ students) with better access to mathematics, thereby bolstering achievement within these two populations. It is also my hope that this

investigation can add to the limited knowledge base concerning the differential success in the college calculus experiences of URM students.

Chapter 4

RESULTS

The purpose of this study was to examine the experiences of URM students in calculus courses at the UD; specifically, to uncover reasons for the difference in success rates between these students and their non-underrepresented counterparts. Using a survey instrument, URM students could be recruited who were identified as successful or unsuccessful in their current course to gauge which challenges students deemed surmountable and which were most daunting. Using interview questions allowed this investigator to obtain richer descriptions of the experiences of seven ethnic minority students.

Survey Results

In total, there were 121 respondents to the online survey; of these participants, 88 completed the entire survey. Of the 88 participants, 15 were underrepresented minority students (URM), and they will be the primary focus of the statistical analysis (with non-URM student data included as a means of comparison). There were seven sections of the survey, including two free response items. The results focus on the following key questions within the exploration of access to mathematics, academic achievement, and race and/or racism:

1. What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and, which do they report to be the most daunting?

2. What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?
3. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
4. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?

URM students reported higher levels of self-efficacy on the survey despite earning lower final grades in calculus courses overall (Table 10). For example, URM students are more confident in performing mathematical tasks ($M = 2.76$, $SD = 1.32$) than their non-URM counterparts ($M = 2.59$, $SD = 1.14$). However, research indicates that mathematics self-efficacy is actually more predictive of mathematics interest, choice of math-related courses, and math majors than achievements in math or outcome expectations (Pajares, 1996).

Table 10. Self-efficacy responses

Self-Efficacy	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
I believe that I will earn at least a C- in my current mathematics course	1.32	2.12	1.36	2.56	1.21	96
I am the kind of person who can succeed in mathematics	1.12	2.47	0.87	2.10	1.51	96
I feel confident in performing mathematical tasks	1.32	2.76	1.14	2.59	0.54	96
I believe that I can complete all of the assignments in my mathematics course successfully	1.35	3.24	1.22	3.02	0.66	96
I have set goals in my mathematics course	0.97	1.94	0.89	2.14	0.40	96
1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree						

Overall, data indicate positive faculty interaction with both URM and non URM students. URM students ($M = 3.50$, $SD = 1.22$) feel slightly more acknowledged by their professors than their non URM counterparts ($M = 3.33$, $SD = 1.13$), and have reported better relationships (Table 11). However, there may be a need for increased office hours offered by professors, as both URM and Non URM students indicated that the availability of the professor outside of class time was not sufficient.

Table 11. Faculty interaction responses

Faculty Interaction	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
I feel comfortable approaching my mathematics instructor for assistance during class time	1.28	2.64	1.26	2.94	0.89	96
My mathematics instructor cares about my progress in the course	1.12	3.21	1.21	2.98	0.72	96
My mathematics instructor supports my progress in the course	1.17	3.14	1.11	3.00	0.46	96
My mathematics instructors respects me	1.09	3.43	1.04	3.61	0.64	96
My mathematics instructor acknowledges me	1.22	3.50	1.13	3.33	0.55	96
My mathematics instructor is available for assistance outside of class time	0.89	4.21	0.69	3.93	1.44	96
I have a good relationship with my mathematics instructor	1.21	3.07	0.94	2.85	0.83	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

As seen in Table 12, URM students are more aware of academic resources provided by the instructor and the university and are more likely to take advantage of these resources that are made available to them ($M = 4.00$, $SD = 1.00$). This may relate to the responses in the Self-Efficacy category, where URM students responded more positively to items in terms of their ability to succeed in mathematics and their confidence in performing mathematical tasks. This relationship also may exist between Self-Efficacy items and how URM students view the relevance of mathematics not only to their intended major, but to everyday life. This relates

directly relating to the principles of SCT, as self-efficacy is one of the four processes that which it is comprised.

Table 12. Academic integration responses

Academic Integration	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
I work on math with other students outside of class time	1.10	3.14	1.29	3.41	0.80	96
I am satisfied with the relevance of mathematics coursework to everyday life	1.20	2.29	1.09	2.28	0.03	96
I can see how math coursework relates to my intended major	1.60	2.43	1.33	2.59	0.43	96
I am satisfied with the level of challenge presented to me in my current mathematics course	1.33	2.93	1.32	2.73	0.56	96
I am aware of the academic resources provided by my mathematics instructor and the university	1.00	4.00	0.72	3.90	0.48	96
I take advantage of academic resources that are available to me	1.25	3.21	1.05	3.38	0.58	96
1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree						

Non-URM students have a higher likelihood of being recognized in the discussion section by name ($M = 2.60$, $SD = 1.22$). But, it is URM students who are more likely to view the discussion section as a community, and feel as though they are an important part of that community (Table 13). Feelings of isolation are more likely to manifest in Non-URM students ($M = 2.99$, $SD = 1.29$), as well; these

students are less likely to ask and answer questions in the discussion section than their URM counterparts. Perhaps it is the fact that URM students view the discussion section as a community space allows them to feel more comfortable speaking out in this setting.

Table 13. Psychosocial integration responses

Psychosocial Integration	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
I view my mathematics discussion section as a community	1.46	3.14	1.14	2.69	1.40	96
I feel I am an important member of my mathematics discussion section	1.51	3.14	1.09	2.60	1.72	96
I know the names of at least a few of the other students in my current mathematics discussion section	1.92	3.00	1.74	3.00	0	96
Other students in my math discussion section know who I am	1.16	2.43	1.22	2.60	0.52	96
I feel isolated in my math discussion section	1.15	2.64	1.29	2.99	1.03	96
I feel comfortable asking questions in my math discussion section	1.55	3.43	0.97	3.72	0.92	96
I feel comfortable answering questions in my math discussion section	1.39	3.36	1.12	3.32	0.12	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

In terms of content delivery, the data points to some rather contradictory results (Table 14). While URM students indicate that they are both actively engaged (M = 3.07, SD = 1.21) and enjoy the lecture format of current calculus courses there is a strong indication that these students would prefer a combination of online,

lecture, and collaborative methods ($M = 3.29$, $SD = 1.44$). As seen in the literature review, differentiated instruction can be a positive reinforcement of basic concepts for underserved learners. It is interesting to note that Non-URM students are not engaged and do not prefer the lecture format as strongly as their minority counterparts ($M = 3.00$, $SD = 1.20$), suggesting that a pedagogical shift to more differentiated methods of instruction would not only benefit URM students, but all students in general. URM students preferred online courses ($M=1.71$, $SD=1.33$) more than non-URM ($M=2.32$, $SD=1.14$). The difference was significant, $t(96) = 2.11$, $p<.05$, $d=0.29$.

Table 14. Content delivery preferences responses

Content Delivery Preferences	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
I prefer my mathematics course to be taught in a lecture format	1.33	2.71	1.20	3.00	0.88	96
I prefer my mathematics course to be delivered in an online format	0.73	1.71	1.14	2.32	2.11**	96
I prefer my mathematics course to be delivered in a collaborative, group work format	1.02	3.50	1.08	3.68	0.63	96
I prefer my mathematics course to be delivered in a combination of online, lecture, and collaborative group work	1.44	3.29	1.15	3.62	1.02	96
I like the way my current mathematics course is taught	1.42	2.79	1.28	2.51	0.80	96
I am actively engaged in my current math course	1.21	3.07	1.15	3.09	0.06	96
My current math course is taught in a way that helps me learn	1.58	2.79	1.25	2.38	1.17	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

Note ** = $p < .05$

In terms of classroom climate, it seems important for the success of URM students for instructors to have confidence in them, more so than the Non-URM students (Table 15). However, a large number of URM students expressed that their instructors communicated to them that they are not capable of doing well in the course; along this same vein, negative stereotypes may have been communicated by instructors to URM students which could have affected classroom performance ($M = 1.36$, $SD = 1.08$). As we have seen in the review of the literature, strong and supportive instructor-student relationships are imperative for minority student success. Lack of these relationships can affect the overall success, and possibly negatively affect self-efficacy. In terms of peer relationships, Table 15 reveals an important finding related to feelings of racial tension in the mathematics classroom, namely, that both URM ($M = 1.21$, $SD = 0.58$) and Non-URM students ($M = 1.39$, $SD = 0.59$) strongly agree that there is racial tension in their mathematics class.

Table 15. Classroom climate responses

Classroom Climate	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
There is racial tension among students in my current mathematics class	0.58	1.21	0.59	1.39	1.14	96
One or more students in my current mathematics class have expressed stereotypes about racial or ethnic groups	0.58	1.21	0.79	1.44	1.13	96
One or more students in my current math class have expressed that I am not capable of doing well in the course	0.84	1.36	0.91	1.67	1.29	96
My current math instructor has expressed that I am not capable of doing well in the course	1.08	1.36	0.95	1.67	1.19	96
My current math instructor has confidence in my ability to succeed in the course	1.29	3.50	0.87	3.29	0.82	96
There is competition among students of different races or ethnic groups for high grades in my current mathematics class	0.76	1.43	0.86	1.67	1.06	96
I feel as if I have been treated differently in my current mathematics class because of my race or ethnicity	0.61	1.29	0.74	1.44	0.78	96
My current mathematics instructor has expressed stereotypes about racial or ethnic groups	1.08	1.36	0.56	1.28	0.44	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

In terms of critical success factors, four trends emerged for URM students, three of which were related to delivery format (Table 16). While the lecture delivery

format appears to be a strong input to the success factor, it should be noted that URM students also found it important to work in collaborative formats ($M = 3.93$, $SD = 1.38$) and have opportunities to work with classmates outside of class time ($M = 3.86$, $SD = 1.10$). On the other hand, Non-URM students found a sense of community more important within the discussion than outside of class. Regardless of the setting, all students seem to find that working with other classmates is an important factor in their success in college calculus.

Table 16. Critical success factors responses

Critical Success Factors	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
Having a math instructor who is approachable is critical to my success in my math course	0.85	4.57	0.84	4.29	1.24	96
Having a math instructor who believes I can succeed is critical to my success in my math course	1.17	4.14	0.88	4.15	0.04	96
Being taught in a collaborative, group-work format is critical to my success in my math course	1.38	3.93	1.05	3.59	1.14	96
Having opportunities to work with other students outside of class is critical to my success in my math course	1.10	3.86	0.99	3.63	0.85	96
Feeling a sense of belonging in my discussion section is critical to my success in my math course	0.97	3.79	1.24	3.33	1.43	96
Having a comfortable and welcoming classroom environment is critical to my success in my math course	0.86	4.14	0.82	4.10	0.18	96
Being taught in an online format is critical to my success in my math course	1.38	2.29	1.08	2.59	0.99	96
Being taught in a lecture format is critical to my success in my math course	1.44	3.07	1.08	3.16	0.29	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

Problematic concerns surfaced in Section VIII of the survey, specifically for Non-URM students (Table 17). Not only are students more likely to feel isolated within the calculus discussion sections ($M = 2.89$, $SD = 1.09$), they reported feelings

of racial tension further inhibiting their success ($M = 1.86$, $SD = 1.02$). Both URM and Non-URM students reported feeling uncomfortable asking questions during the discussion section and this inhibited their ability to succeed in the course. A more standardized vetting and training protocol for teaching assistants could improve the quality and preparedness of these instructors, making students feel more comfortable in classroom and may prevent these types of problems from occurring in the future.

Table 17. Other possible interference factors responses

Other Possible Interference Factors	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
Feeling isolated in my discussion section interferes with my ability to succeed in my math course	0.85	2.50	1.09	2.89	1.38	96
Not feeling comfortable asking questions in my discussion section interferes with my ability to succeed in my math course	1.27	3.07	1.15	3.18	0.35	96
Racial tension in my discussion section interferes with my ability interferes with my ability to succeed in my math course	0.76	1.50	1.02	1.86	1.37	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

Similar to the critical success factors section of the survey, four trends emerged, three of which were related to delivery format (Table 18). URM students responded positively to items in regard to the inclusion of both collaborative and online components in the classroom, as well as the inclusion of more lectures; Non-URM students' responses were similar but not as strong. Finally, despite not having voiced racial relations as an issue in earlier items, URM students requested a need for

racial relations to improve in order to succeed in the course ($M = 3.14$, $SD = 1.23$), as did Non-URM students ($M = 2.82$, $SD = 1.07$). This may be an indication that covert, rather than overt, incidents of racism and discrimination may be occurring in the classroom that need to be addressed, as Non-URM students also responded to items positively in regard to racial tensions in the classroom in earlier sections of the survey as well.

Table 18. Pedagogical supports responses

Pedagogical Supports	URM n = 17		NON-URM n = 81		<i>t</i>	<i>df</i>
	SD	M	SD	M		
Instruction that got me actively engaged in class would help me succeed in my math course	0.83	4.07	0.92	4.04	0.12	96
Instruction that included more lectures would help me succeed in my math course	1.38	3.07	1.14	3.10	0.09	96
Instruction that included more collaborative group work would help me succeed in my math course	1.55	3.64	1.00	3.73	0.30	96
Instruction that included more online components would help me succeed in my math course	1.49	2.71	1.25	2.92	0.60	96
Making the classroom more welcoming would help me succeed in my math course	0.86	4.14	0.95	4.04	0.40	96
Improving racial relations in class would help me succeed in my math course	1.23	3.14	1.07	2.82	1.09	96
Feeling comfortable asking my instructor for help would help me succeed in my math course	0.65	4.43	0.65	4.34	0.51	96

1=Strongly Agree 2=Agree 3=Neutral 4=Disagree 5=Strongly Disagree

In the free-response section of the survey, 18% of URM respondents reported problematic concerns in terms of professor efficacy and quality. This statement “Professor A could not care less whether we do well or not...I understand the class better when I don’t go to class,” pulled from the free response section of the survey, should be weighted heavily. It not only implies a lack of compassion on the part of the instructor, it negates the need for an instructor all together. It also relates to the data above in regards to questions in the Critical Success Factors section of the survey – URM students specifically are in need of faculty who communicate to them that they believe that they can succeed in the course. Table 19 aligns the nine sections of the survey with the four key questions underlying this study.

Table 19. Survey sections aligned to key questions

Survey Section	Key Question
Self-Efficacy	What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?
Faculty Interaction	What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
Academic Integration	What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
Psychosocial Integration	What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses? What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
Content Delivery Preferences	What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?
Classroom Climate	What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
Critical Success Factors	What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?
Other Interference Factors	What challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting?
Pedagogical Supports	What kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes?

Interview Results

As stated above, there were seven interview participants. Initially, the criteria for selecting these interview participants included:

1. Self-identification as an underrepresented minority student
2. Completion of the *Calculus Course – Student Attitudes Survey* online

These criteria were largely due to UD's definition of who is considered underrepresented on campus. However, after preliminary survey analysis, interview participants were expanded to include those who may have experienced racially based discrimination(s) in the classroom, including Asian American and International students. The results are discussed in order by question, including challenges raised and solutions posited.

Key Question 1

Key question one asks what challenges do underrepresented minority students at the University of Delaware (UD) report facing in calculus courses? Which of these challenges do they report to be surmountable and which do they report to be the most daunting? Table 20 lists the challenges the students mentioned and possible solutions for each.

Table 20. Challenges for Key Question 1

Student	Challenge	Solution
1	Teaching Assistant: not inclusive or welcoming, student was made to feel stupid	Standardized training and vetting of TA's
2	Pace of lecture; microaggressions witnessed in the classroom manifested feelings of discomfort (peer-driven)	Differentiation of instruction to reach and teach all learners; Racism and discrimination sensitivity training of students (possibly through residence assistants)
3	Teaching Assistants: poorly trained, inconsistent learning environments within discussion sections Microaggressions manifested by peers	Standardized training and vetting of TA's Racism and discrimination sensitivity training of students (possibly through residence assistants)
4	Little interactivity between students and professor and student to student during class makes learning static	More engaging, active learning activities in the classroom
5	Mathematics anxiety Fear of asking questions	Increase level of comfort within classroom setting
6	None listed	
7	Slow, repetitious learner of mathematics (Pace)	Pace and differentiation of instruction

Issue #1: Teaching assistants

Clearly there is a wide variance in the vetting and training of teaching assistants, and how discussion sections are held in terms of overall classroom climate and pedagogy. If all students are to receive an equitable education, they must be taught by properly trained and knowledgeable TAs who are familiar with the calculus curriculum and can teach in a variety of contexts.

Issue #2: Pace of lecture

Alongside of TA's, Faculty members must be able to teach in a variety of contexts, and vary the pace of the lecture to meet the needs of all learners in the classroom.

Issue #3: Microaggressions

Students should receive some kind of informal sensitivity training so that they know what could be damaging to their fellow peers. Often, the initiator of such messages may be unaware they have engaged in a behavior that is in, fact cumulative – one of a lifetime of demeaning messages that erode the victim's confidence. Given the level of racial, ethnic, and socio-economic diversity found in college mathematics classrooms, these peer aggressions present a concern in that they have the potential to diminish or even invalidate potential learning experiences.

Issue #4: Interactivity

Integrating more active learning, such as IBL centers, as referenced in the Review of the Literature, not only get students working together but also IBL students reported higher gains in understanding concepts, mathematical thinking, confidence in doing and communicating about mathematics, persistence, and positive attitudes about mathematics learning.

Issue #5: Mathematics anxiety

Faculty members can ease mathematics anxiety and the trepidation of students calling out by increasing the comfort level within the classroom setting through the

following critical practices: honoring student experiences, thoughtful classroom setup and structure, and social and emotional safety (Southern Poverty Law Center, 2016).

Key Question 2

Key question two asks what kinds of pedagogical changes do underrepresented minority students at UD recommend for the calculus courses at UD, and what rationales do they provide for these changes? Table 21 lists the challenges the students mentioned and possible solutions for each.

Table 21. Challenges for Key Question 2

Student	Challenge	Solution
1	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	Increased opportunities for grades; integration of group work
2	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	Integration of a calculus prep course
3	None (generally pleased with the format and content of calculus courses sans discussion sections)	
4	None (generally pleased with the format and content of calculus courses sans discussion sections)	
5	Struggling solo learners	Integration of group work
6	None (generally pleased with the format and content of calculus courses sans discussion sections)	
7	Feasibility of working in small group settings	Collaborative work in discussion sections

Issue #1: Bridge the gap between high school and college calculus

This issue was cited by two different students, and several solutions were posited. To mirror the curriculum and pedagogy of secondary classrooms, it was suggested that there be increased opportunities for graded work in the course. Though its feasibility may be unlikely due to course scheduling, the introduction of a calculus preparatory course into the mathematics sequence was also suggested to assist struggling learners.

Issue #2: Struggling solo learners

The integration of group work was also cited as a solution to Issue #1; to summarize a statement by Student 5, a collective group of learners is better than a single learner and working together can benefit the entire group.

Issue #3: Feasibility of working in small-group settings

Student 7 cited her desire to work collaboratively in the classroom, but was not sure of its feasibility due to the nature of the lecture model. The discussion section is a perfect opportunity for students to work in small-group settings to demonstrate a mathematical idea or strategy to their peers, and likewise, learn another concept or strategy from fellow students.

Key Question 3

Key question three asks what role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses? Table 22 lists the challenges the students mentioned and possible solutions for each.

Table 22. Challenges for Key Question 3

Student	Challenge	Solution
1	Works on problems with friends outside of class but no collaboration in-class	Integration of collaborative work
2	High expectations of prior mathematical knowledge	Pre-testing of students at the beginning of the semester to gauge prior knowledge and skills
3	Unreasonable expectations of students in terms of workload by primary faculty member(s)	More appropriate scheduling of workload and exam schedule for students
4	Unreasonable expectations of students in terms of workload by primary faculty member(s)	More appropriate scheduling of workload and exam schedule for students
5	Primary faculty member – not helpful in learning Teaching assistant - helpful	More engaging faculty members
6	Primary faculty member – emotionally distant from students	Building and maintaining relationships with students
7	Primary faculty member – lack of care, low warmth	Building and maintaining relationships with students

Issue #1: No in-class collaboration

Student 1 commented that he works with his peers outside of class on homework assignments when he finds he is having trouble; he also suggested the integration of group work as a solution for the issue of bridging the gap between the rigors of high school and college calculus. In this collaborative work, students can discuss and share ideas; and work cooperatively to solve a problem or investigate a mathematical concept.

Issue #2: High expectations of prior mathematical knowledge

Two students cited this issue; while all students are given a placement test prior to being placed in a calculus course, this type of high-stress high-stakes test may not gauge prior mathematical knowledge and skills adequately. Formative assessments at the beginning of the semester should be given to students to identify not only their skills, but also their needs.

Issue #3: Unreasonable expectations of students in terms of workload

Several students cited the issue of faculty members having an unreasonable expectation of them in terms of an overly heavy workload, compounded by the fact that many of the assignments were not even counted for credit. It was suggested by students that faculty obtain a better understanding of the courses and programs that students are enrolled in, and to schedule the mathematics workload and exam schedule accordingly.

Issue #4: Primary faculty member not an engaging model

Student 5 noted that her instructor was not at all a factor in her learning, mainly because she found him hard to follow. Again, one core premise within the social cognitive theory is learning through observation or vicarious learning. Live demonstrations of a skill by the professor typify the notion of modeling. However, if the relational processes involving attention, retention, production, and motivation are not present during observation, students do not, as in this case, fully understand or engage with the model (Deiner, Wolters, & Benzoni, 2014).

Issue #5: Primary faculty member emotionally distant from students, showing lack of care

In some cases, students described their relationships with faculty members using such sterile terms as “professional” and “distant;” some even went as far as to describe their relationships as “hostile.” Generally, there was a desire for students to have a level of acknowledgement from their instructors; as Student 2 describes, “not just be another number.” Positive student-faculty interactions have long been associated with positive outcomes for students, including increased effort, greater student engagement, a higher level of content acquisition (Pascarella and Terenzini 2005), and a greater likelihood of persistence and subsequent college completion (Hoffman, 2014).

Key Question 4

Key question four asks what factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses? Table 23 lists the challenges the students mentioned and possible solutions for each.

Table 23. Challenges for Key Question 4

Student	Challenge	Solution
1	Personal negative attitudes towards mathematics	Reaching out for support from outside academic resources from the university
2	Slow, repetitious learner of mathematics	Pace and differentiation of instruction
3	Personal desire for deeper understanding of mathematical concepts	Reaching out for support from outside academic resources from the university
4	Personal desire for deeper understanding of mathematical concepts	Reaching out for support from outside academic resources from the university
5	Mathematics anxiety (Perceived) isolation in the classroom	Collaborative work in the classroom
6	Personal desire for deeper understanding of mathematical concepts	Reaching out for support from outside academic resources from the university
7	Slow, repetitious learner of mathematics	Pace and differentiation of instruction

Issue #1: Personal negative attitudes towards mathematics

Student 1’s negative attitudes could be tied to the increasing level of difficulty he encounters as he reaches higher levels in mathematics. That said, if he were to reach out for support from outside academic resources, such as tutoring services, his levels of self-efficacy may improve, and he may find increased success in calculus.

Issue #2: Slow, repetitious learner of mathematics

Two students self-reported as “slow learners” of mathematics; in the case of Student 2, this negatively affected her self-efficacy at first in that she believed that she could not learn calculus at all. However, if the instructor were to modify the pace

and context of the instruction to meet the needs of all learners in the classroom, self-efficacy of students like Student 2 would more than likely be positively affected.

Issue #3: Personal desire for deeper understanding of mathematical concepts

Several students cited this issue; however, none of the students posited the solution of reaching out to resources external to the course to strengthen mathematical knowledge and skills. This was an unexpected finding based on the self-reported attitudes towards mathematics by the majority of the students.

Issue #4: Mathematics anxiety/(perceived) isolation in the classroom

For Student 5, her mathematics self-efficacy is indefinitely tied to her mathematics anxiety and perceived feelings of isolation within the classroom setting. She cites opportunities to learn from one another as a key in helping her to communicate mathematically.

Comparing Interview to Survey Results

Table 24 lists the challenges reported by the underrepresented minority students and identifies the survey section corresponding to those challenges. Each section's challenges are discussed in turn as follows. It is interesting to note that the survey reflected that both URM and non-URM students felt the need for racial relations to improve in the classroom and microaggressions manifested by peers was seen as a challenge. Approachability of instructors was an issue for URM students on the survey; the challenge of interactivity between instructor and student was also identified in the interview data. While URM students preferred the lecture model over

their non-URM counterparts, as seen in the survey, the interview data indicated issues with the model itself, mainly its fast pace.

Table 24. Challenges reported by underrepresented minority students

Student	Challenge	Aligns with Survey Section
1	Teaching Assistant: not inclusive or welcoming, student was made to feel stupid	Psychosocial Integration; Other Possible Interference Factors
2	Pace of lecture; microaggressions witnessed in the classroom manifested feelings of discomfort (peer-driven)	Other Possible Interference Factors
3	Teaching Assistants: poorly trained, inconsistent learning environments within discussion sections Microaggressions manifested by peers	Content Delivery Preferences; Other Possible Interference Factors
4	Little interactivity between students and professor and student to student during class makes learning static	Faculty Interaction
5	Mathematics anxiety Fear of asking questions	Other Possible Interference Factors; Psychosocial Integration
6	None listed	
7	Slow, repetitious learner of mathematics (Pace)	Critical Success Factors

Pedagogical Recommendations

Table 25 lists the pedagogical changes recommended by URM students. There were several similarities between the interview and survey data results in terms of psychosocial integration; students in both the survey and interview pools reported feeling isolated within the discussion sections and uncomfortable asking questions. Also, while not noted as a challenge, URM students in both the interview and survey

responded positively to questions regarding the inclusion of collaborative group work in the course.

It is interesting to note that in both the interview and survey results that race was noted as an interference factor to students; in the survey, both URM and non-URM students requested a need for racial relations to improve in order to succeed in the course. In the interviews, incidents of microaggressions were noted. Perhaps it is these covert incidents of racism that prevent true equity and fairness in the classroom, making it hard for underserved learners to succeed.

Both the survey and interview had some rather contradictory results in content delivery preferences. While there was an indication that students liked the current lecture format of mathematics courses, there was also a preference towards a collaborative model. While some students in the interview had strong feelings about working in groups, others were happy with the way things were. However, Student 3 aired complaints of the variance in content delivery amongst the discussion sections, suggesting that teaching assistants be trained and follow a standard curriculum.

Contradictory results emerged between the interview and survey results in terms of faculty interaction. For example, while URM students reported feeling slightly more acknowledged by their professors and having better relationships with them than their non-URM counterparts, many interview participants reported having no relationship to “hostile” relationships with their professors.

Although students on the survey indicated that the lecture format was a critical success factor, two students on the survey indicated that it was the pace of the lecture that was an inhibitor to success. These same students also noted that their professors

were not easy to approach in terms of asking questions in class (which would have been helpful to them); it was noted on the survey that approachability of the professor was not a critical success factor either for URM or non-URM students.

Table 25. What kinds of pedagogical changes do underrepresented minority students at UD recommend?

Student	Challenge	Aligns with Survey Section
1	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	None
2	Feels a need for a bridge of the gap between the rigors of high school and college calculus courses	None
3	None (generally pleased with the format and content of calculus courses sans discussion sections)	
4	None (generally pleased with the format and content of calculus courses sans discussion sections)	
5	Struggling solo learners	Psychosocial Integration
6	None (generally pleased with the format and content of calculus courses sans discussion sections)	
7	Feasibility of working in small group settings	Content Delivery Preferences

Roles

Table 26 lists the reported roles that instructional personnel (faculty, teaching assistants) as well as fellow classmates play. In the interview results, URM students spoke of feelings of isolation within the discussion section, as well as a fear of asking questions; this was also reflected in the non-URM student survey results. As a remedy to students struggling by themselves, several students in the interview protocol remarked on the integration of collaborative group work.

As noted above, several students in the interview protocol preferred collaborative work as a content delivery method; student 7 was curious about its

feasibility at the post-secondary level when lecture is the dominant method of delivery. All students on the survey responded positively about preferring collaborative, group work.

Table 26. What role do instructional personnel (faculty, teaching assistants) as well as fellow classmates play in the success or failure of underrepresented minority students in calculus courses?

Student	Challenge	Aligns with Survey Section
1	Works on problems with friends outside of class but no collaboration in-class	Academic Integration
2	High expectations of prior mathematical knowledge	Faculty Interaction
3	Unreasonable expectations of students in terms of workload by primary faculty member(s)	Faculty Interaction
4	Unreasonable expectations of students in terms of workload by primary faculty member(s)	Faculty Interaction
5	Primary faculty member – not helpful in learning Teaching assistant - helpful	Faculty Interaction
6	Primary faculty member – emotionally distant from students	Faculty Interaction
7	Primary faculty member – lack of care, low warmth	Faculty Interaction

Self-efficacy

Table 27 lists the factors reported to have the most impact on the self-efficacy of underrepresented minority students in college calculus courses. While Student 1 touches upon the fact that he is welcome to the idea of working with friends on math outside of class, this same type of collaboration does not happen in class and could aid in his learning. This pattern also emerges in the survey data: while both URM and non-URM students indicate that they work with students outside of class on

mathematics, they still prefer to work collaboratively in class as well, even though the current model is lecture.

In terms of faculty interaction, having unreasonably high expectations of students, showing low warmth or care for students, or not being helpful, can all be attributed to lack of supportive instructor-student relationships. As we have seen in the review of the literature (Pascarella and Terenzini, 2005; Hoffman, 2014), strong and supportive instructor-student relationships are imperative for minority student success. Lack of these relationships can adversely impact success, and possibly lower self-efficacy. Nevertheless, data collected from the survey indicated strong and positive instructor-student relationships between both URM and non-URM students and faculty.

Table 27. What factors have the most effect on the self-efficacy of underrepresented minority students in college calculus courses?

Student	Challenge	Aligns with Survey Section
1	Personal negative attitudes towards mathematics	None
2	Slow, repetitious learner of mathematics	Academic Integration
3	Personal desire for deeper understanding of mathematical concepts	Self-efficacy
4	Personal desire for deeper understanding of mathematical concepts	Self-efficacy
5	Mathematics anxiety (Perceived) isolation in the classroom	Psychosocial Integration
6	Personal desire for deeper understanding of mathematical concepts	Self-efficacy
7	Slow, repetitious learner of mathematics	Academic Integration

Both URM and non-URM students responded positively to items regarding awareness of outside academic resources that the university has to offer as an aid in mathematics learning. Student 2 took advantage of these resources and sought out a tutor, who helped address the issues she had with pacing in the main lecture of the class.

In terms of self-efficacy, although the interview pool was a fairly balanced mix of successful and unsuccessful students, URM students reported higher levels of self-efficacy on the survey despite earning lower final grades in calculus courses overall. Moreover, URM students reported higher levels of goal setting on the survey than their non-URM counterparts.

Although the interview protocol revealed a number of URM students feeling isolated in the discussion section, including Student 5, the survey data revealed that non-URM students were more likely to manifest feelings of isolation. URM students were more likely to view the discussion section as a community and were more likely to be recognized by name than non-URM students.

Results

Four themes emerged across the two sets of data. Two of these themes were identified in the literature as variables impeding minority student success; one theme is part of the SCT and the last theme is a pedagogical change desired by students in the classroom.

Theme 1: High self-efficacy among URM students does not necessarily result in high grades

URM students reported higher levels of self-efficacy on the survey despite earning lower final grades in calculus courses overall. For example, URM students reported feeling more confident in performing mathematical tasks than their non-URM counterparts. URM students also reported higher levels of goal setting. This was confirmed in the interview results of three participants. However, research indicates that mathematics self-efficacy is actually more predictive of mathematics interest, choice of math-related courses, and math majors than achievements in math or outcome expectations (Pajares, 1996).

Theme 2: Isolation and feeling uncomfortable asking questions during discussion section

Feelings of isolation manifested in a number of the interview participants who felt discouraged from asking questions in their discussion sections. As noted in the literature review (Tinto, 1987), finding a positive level of comfort on a college campus is a key factor in the academic success of minority students. Feelings of isolation were also felt among non-URM students in the survey data. Thus, regardless of race or ethnicity, all students can manifest these types of feelings which can impede success in the college calculus courses.

Theme 3: Microaggressions and covert incidents of racism in the classroom

In the *Other Possible Interference Factors* section of the survey, both URM and non-URM students revealed that an improvement in racial relations would help

them succeed in the course. This may mean that covert, rather than overt, incidents of racism need to be identified and countered in order for there to be a fair and equitable learning environment in the classroom. Two interview participants spoke to microaggressions occurring in the classroom; both were peer-mitigated and this may call for a need for student sensitivity training, perhaps at the residential level.

Theme 4: Integration of collaborative groupwork

Three sections of the survey, namely *Psychosocial Integration*, *Critical Success Factors*, and *Content Delivery Factors*, addressed the issue of collaborative group work. In almost all instances, both URM and non-URM students responded positively to items regarding preferences towards collaborative group work and working with other students on mathematics. Several students on the interview protocol noted a desire to work in groups; one student specifically suggested collaborative work as a solution to aid struggling learners.

Chapter 5

RECOMMENDATIONS AND CONCLUSIONS

This investigation has attempted to capture the experiences of ethnic minority students, primarily freshmen and sophomores, enrolled in calculus courses at UD, in their own voices. In doing so, the investigator set out to write their stories by examining their educational trajectories. Investigating mathematical experiences through the triangulated data analysis approach and using critical race and social cognitive theory lenses led to rich data concerning student experiences in mathematics classes that may be generalized across the curriculum. As indicated in the results sections, participants are undergraduate students in a variety of majors who have found differential success in calculus courses. The data indicate that academic achievement (success in mathematics) is based in part on the following factors: the relationship with university personnel, specifically the calculus lecture professor, but also the discussion section teaching assistant, and positive versus negative attitudes towards mathematics.

Participant Recommendations

Participant recommendations were analyzed from both the surveys and the interview sessions.

Survey Instrument

On the survey instrument, ten URM respondents answered the free-response item related to recommendations for improvement to calculus courses offered at the

University. Figure 5 outlines four categories of responses that were identified: Curriculum and Instruction, Professor Interaction, Exams, and None.

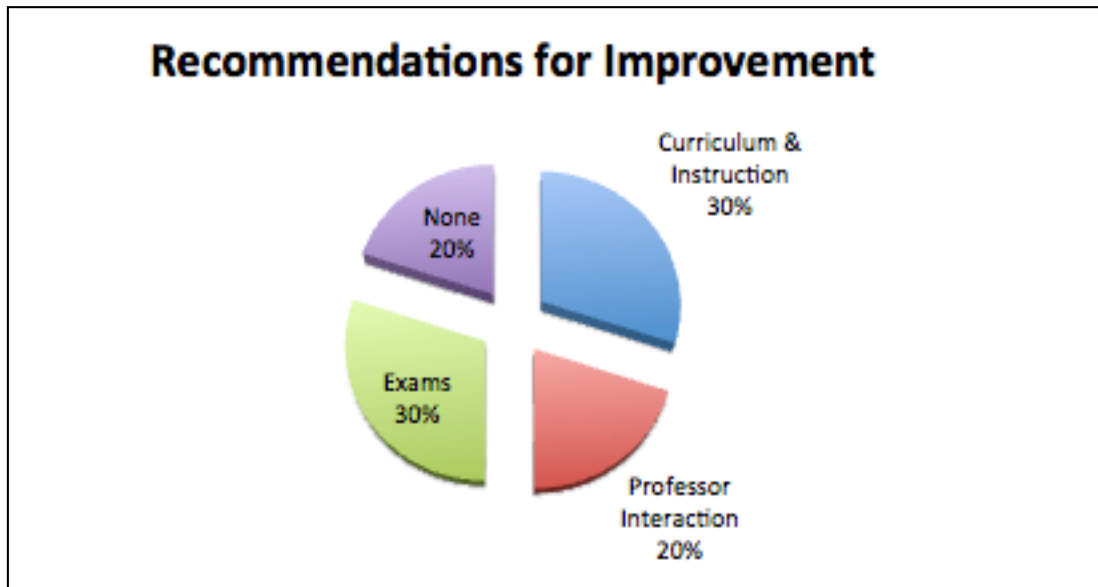


Figure 1. Survey instrument recommendations for improvement

In terms of improvements under curriculum and instruction, smaller class sizes, longer class times, and pace of instruction (noted as being too fast) were requested. Students are also seeking more one-on-one interaction in the instructional lecture as seen within the findings of the qualitative interviews. Student 4 makes a case for this point in terms of the WebAssign assignments in her qualitative interview (see chapter 3). Finally, clarity of instruction within exams, more examples of similar assessments provided prior to exams, and less rigorous exams were noted on the free-response items. The students who offered no recommendations noted the differentiation of instruction between lecture and discussion section to “help cover different learning abilities” and the fact that the classes taught this way make them feel successful in class.

Qualitative Interviews

Within the qualitative interviews, six of the seven participants offered recommendations for improvement in the calculus courses offered at the university. Figure 6 outlines the following categories that were identified: classroom curriculum and instruction, discussion section curriculum and instruction, university personnel, collaborative learning opportunities, and none. Table 28 specifies the intervention types that were mentioned within the qualitative interviews.

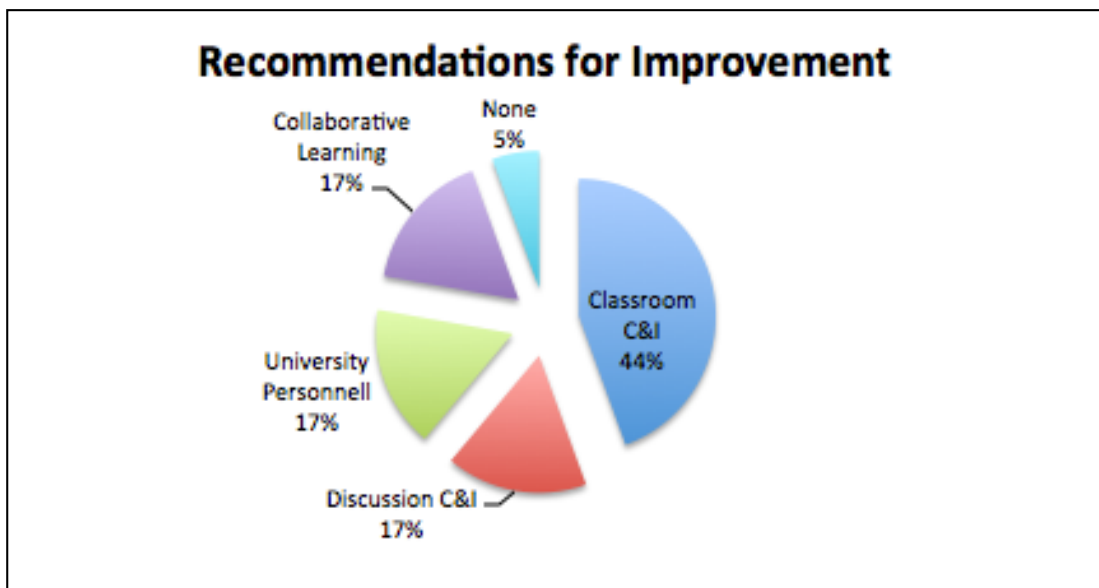


Figure 2. Qualitative interview recommendations for improvement

Table 28. Qualitative interviews: Recommendations for improvement

Qualitative Interviews: Recommendations for Improvement	
Code	Intervention Type
Classroom Curriculum and Instruction	Calculus Prep Course More Opportunities for Grades Active Learning Activities in Lecture Improved WebAssign Activities Smaller Class Sizes Pace
Discussion Section Curriculum and Instruction	Common Discussion Sections, Longer Discussion Sections
University Personnel	One-on-One Work w/ Professor, Vetted TA's
Collaborative Learning	Group Work

These recommendations are more thoroughly explained through the participants' voices in Chapter 4. Notably, interventions common to both the survey instrument and the qualitative interviews, such as the pace of instruction and one-on-one interactions with the professor, are under the direct control of the course professor. This reinforces that a large determinant of student success in a math course is dependent upon the action (or inaction) of the professor.

Much of the literature regarding success in mathematics resonates with the interventions provided by the participants. For example, the University of El Paso study (see Chapter 1) relates to mathematics and cooperative learning, and how students were shown to thrive in group environments. Peer relationships may have a positive effect on the academic achievement of minority students, as seen in The Mathematics Workshop Program at the University of California Berkeley (now *The Emerging Scholars Program*). This program has been expanded to a number of colleges and universities because its success rate has been phenomenal. Positive

student-faculty interactions have long been associated with positive outcomes for students, including increased effort, greater student engagement, and a higher level of content acquisition (Pascarella & Terenzini 2005). While instructional technologies are an important and imperative component of the mathematics classroom in the 21st century, they must be effective, current technologies that present complex yet relevant computational challenges to our students (Estrella Mountain Community College, 2002). Finally, active learning activities such as IBL may be of benefit to URM student success; the Modified Moore Method, a technique in which students present course content, in part or wholly by themselves, creates more effective mathematical inquiry-based accessibility for students in an atmosphere that solidly grounds authentic understanding of the many principles of mathematics (McLoughlin & Padraig, 2009).

Final Recommendations for URM Success in Calculus Courses

Based on the suggestions of the participating students as a result of their experiences paired with my research of the existing literature, I offer the following recommendations for modifications within the calculus sequence at UD:

- Provide opportunities for one-on-one interactions with the professor during lecture
- Provide opportunities for active learning activities during lecture
- Make modifications to WebAssign to provide more engaging, relevant content
- Provide opportunities for collaborative learning during discussion sections

Opportunities for One-on-One Interactions with the Professor During Lecture

These interactions could be as simple as inspecting the classroom and checking student work for errors and accuracy. Student 1 noted that this type of interaction makes him feel that the professor is truly invested in his and his peers' performance in class. This type of interaction allows more opportunities for the professor to model problems for the students, one of the key concepts of SCT.

Training for faculty and teaching assistants in regard to sensitivity towards students is imperative in order to create an environment of comfort in the classroom. A good learning environment requires the instructor to build strong personal relationships with their students, have a non-derogatory sense of humor, and take time to relax throughout the lesson. Warmth, caring, personal support, and nurturing students' competence is important and can make a difference for underrepresented students, as well as for all students in general.

Opportunities for Active Learning Activities During Lecture

As an example, the GoodQuestions Project at Cornell University (Department of Mathematics at Cornell University, 2008) sought to improve calculus instruction using a pedagogical strategy that raised the visibility of key concepts and promoted a more active learning environment through the use of clicker technology. The essence of the approach was to develop applications that:

- Stimulate students' interest and curiosity in mathematics
- Help students monitor their understanding

- Offer students frequent opportunities to make conjectures and argue about their validity
- Reflect the role of student prior knowledge and misconceptions in building conceptual understanding
- Provide instructors with frequent formative assessments of what their students are learning
- Support instructor's efforts to foster an active learning environment (Cornell University, 2008).

Modifications to WebAssign to Provide more Engaging, Relevant Content

Data collected, both in the survey and the interview protocol, indicated that students were generally unhappy with the content presented on the WebAssign assignments, stating that it did not adequately prepare them for the rigors of exams. In fact, there may be a link to the fact that students requested less rigorous exams as a result. Friedlander et al. (2014) stresses the importance of relevant, rigorous exams to adequately support mathematical knowledge; the preparation for the exams, the WebAssign work, should also meet the relevant standard being set.

Opportunities for Collaborative Learning During Discussion Sections

According to Johnson et al. (1994), there are five basic elements of cooperative learning: positive interdependence (students seeing the importance of working as a team), face-to-face interaction (students working in environmental situations that promote eye contact and social space to engage in discussions), group behaviors (the interpersonal, social, and collaborative skills needed to work with others successfully), individual accountability (each person's responsibility to the

group), and group processing (analyzing one’s own group and the group’s ability to work together). Table 29 gives examples of cooperative learning activity structures. Of these interventions, the inclusion of collaborative learning opportunities is the most favored of the recommendations based on data collected from the study and the related literature regarding URM student success in mathematics.

Table 29. Cooperative learning activity structures

Structure	Definition	Math Example
1. Categorizing	1. Students analyze and classify objects based on specific criteria.	1a. Categorize based on attributes 1b. Categorize numbers in various ways: odd, even, multiples
2. CO-OP	2. Each student studies a part of a topic and then presents his or her information to group teammates	2a. Study classmate preferences on certain topics and construct graphs. 2b. Learn algebraic formulas and solve equations together.
3. Numbered heads	3. After each team member numbers off, students discuss the answer to a question. Then, in a large group, the teacher calls a specific number and group to answer the questions.	3a. Discuss the answer to a mental computational problem. 3b. Apply the definition of a rule previously introduced to problems; explain the application of the rule.
4. Round the table	4. Students work on problems jointly by passing the problems around the table for each member’s response.	4a. Pass a worksheet with multiplication facts for each member to answer a problem. 4b. Pass problems for each member to compute the next step of an algorithm.
Adapted from B. Andrini (1991) Cooperative learning & mathematics. San Juan Capistrano, Ca: Resources for Teacher, Inc.		

While many practitioners tout the efficacy of cooperative learning for student learning and development, challenges can be faced in its implementation, particularly in relation to the peer-to-peer binary relationships. In research conducted by Sheehy

(2004), it was found that binary tensions occurred within three general components of cooperative learning: the environment, the group members, and the individual. According to Sheehy, “Issues of being polite (or being selfish), sharing (not sharing) ideas, resisting (or submitting to) perceived powers were raised by the participants as potentially problematic aspects of working with group members and were often difficult to reconcile. As the participants reflected on and discussed the notion of individuality within a cooperative group, they agreed that both a desire for individual ownership of the mathematics, and a subsequent search for autonomy led to yet other binary tensions” (Sheehy, 2004, p. 175). Therefore, it is important for educators to understand the issues and tensions emerging from cooperative learning before trying to implement it in their own classrooms.

Limitations of the Study

A limitation of the study is that all of the participants of the study, both in the survey instrument and the interviews, attended a PWI in the Mid-Atlantic region of the United States. Most of the interview participants were originally from the Mid-Atlantic region as well, implying that the majority of participants’ experiences were viewed through an “east coast” lens. The concentration of the majority of the ethnic minority populations (primarily African-American and Hispanic/Latin@) in the U.S. are on the east coast, from New York to Florida, stretching southwest to Louisiana. Including more URM students who had completed their post-secondary experiences in other areas of the United States, the South for example (especially given the large concentration of African-American students in the South), could have provided a richer data set and additional insights.

While qualitative interview research supports a sample size of seven participants, a larger pool was originally sought, as it would have proven valuable in the investigation of URM student experiences in college calculus courses. Further, including more success stories could have continued, and will continue, to build our understandings of the experiences of URM students in mathematics, especially at the college level. The findings from the seven interview participants cannot be generalized to all ethnic minority students in calculus courses at the university level.

Another limitation was that there was only one male participant within the qualitative portion of the study. In addition, this study was unable to include other marginalized groups, such as Pacific Islanders and Native Americans. Perhaps the inclusion of these marginalized groups employing a critical race perspective might have given “voice” to other excluded populations pertaining to their mathematical experiences (Bernal, 2002; Dixson & Rosseau, 2005).

Suggestions for Future Research

Several exciting opportunities for future research relating to the differential success of underrepresented minority students in college mathematics came from this investigation. It is hoped that these suggestions will also be valuable for other marginalized groups (i.e. Asian/Americans) as well as for the dominant culture. The suggestions put forth in this investigation could provide insights to the mathematics education community, to researchers, and policymakers alike.

The investigator recommends that future mathematics education research use critical race theory as a lens to analyze different phenomena for student success rather than avoid it for political reasons. Both Students 3 and 4 mentioned the high

population of international mathematics professors at UD and that occasionally a language barrier presented a challenge (albeit surmountable) in their success in mathematics. Future research could examine the hiring practices of mathematics faculty at PWIs employing a critical race lens; furthermore, research should consider the implications of having several international mathematics professors on staff.

As mentioned in the limitations section, the qualitative portion of this study had only one male participant. Future research could examine the mathematics experiences of more male participants, as well as members of other marginalized groups that the university does not necessarily consider “underrepresented” using Critical Race Theory (CRT). Within her interview, Student 2 mentioned strong ties to her faith; further research should continue to examine the relationships between spirituality and achievement among African-American students.

Social cognitive theory relies on observational learning through perceived self-efficacy, goal setting, outcome expectations, and self-regulation; the learner in an individual setting (i.e., lecture) typically performs all of these acts. Future research could answer whether social cognitive principles could extend to collaborative settings such as whether students with greater self-efficacy are more confident in their abilities to be successful when compared to their peers with lower self-efficacy.

Conclusion

Through this research study, the investigator has explored the experiences of underrepresented minority students in college calculus courses at UD. The investigation, driven by data, extended beyond the URM scope to include other ethnic minority students within the qualitative interview portion of the study. The stories of

the seven interview participants are empowering, motivating, and thought-provoking. The experiences that some of the participants had while negotiating their race and racism in a mathematics setting is noteworthy.

My personal interest in this area of research was predicated upon my own personal experiences in mathematics at UD. Having felt the sting of a microaggression from a former classmate, having struggled through courses and having felt a sense of hopelessness that many of my interviewees experienced, I wanted to investigate the roots of the “achievement gap” in calculus. Therefore, I began to explore literature on critical race theory and research employing CRT as a theoretical lens. Due to the instructional delivery method of the courses (lecture), the social cognitive theory also seemed an appropriate lens to view and shape the research.

As previously indicated, the recommendations made in this chapter are paramount. If we as educators, researchers, and policymakers are concerned about making mathematics, specifically calculus, accessible to underrepresented students, then we must act now to attract students to this field. The ballooning of STEM fields, and the increase of coursework, academic, and business opportunities within STEM, coupled with the dearth of people of color in these fields are precipitated by the situations and experiences observed and enumerated within this paper. Is failure to launch into a predominately white institution resulting from the inability to progress in math, technology, and the sciences providing another avenue for discrimination and marginalization of an underrepresented group in a burgeoning field of study and

employment opportunity? With regards to expressing the seriousness of the participation of students of color in mathematics, Kenshaft (2005) states:

It seems crucial that we provide the pleasure of mathematics to as many humans as possible, and that the mathematical communities become maximally diverse, reflecting the gender, sexual orientation, age, race, and ethnic composition of the outside community. Such diversity is vital for the health of the mathematical enterprises, the health of humankind, and the health of the larger global community of all living creatures (p. 209).

In stating this, Kenshaft (2005) points out that we must strive to create mathematical communities that truly reach and teach the wide variety of students coming from different experiences and avenues. In conducting this study, the investigator has developed a vested interest regarding the participation of underrepresented students in mathematics education, specifically at the undergraduate level. I am hopeful that those who read this paper will take the opportunity and initiative to encourage the success of underrepresented students in college calculus (as well as any math course required for academic and industry careers in STEM). Mathematics instructional practices should be established that enable all underrepresented students to gain and attain success in college mathematics at UD and all predominately white institutions.

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Appendix A

SURVEY INSTRUMENT

Demographics

1. Select the current course in which you are enrolled: Math 221, Math 241
2. Select your Current Course Grade: A, B, C, D, F, Unsure
3. Select your race/ethnicity:
 - White/Non-Hispanic
 - African-American
 - Asian/American
 - Hispanic/Latin@
 - Pacific Islander
 - Native American
 - Mixed Race
 - International
 - Other
4. Select your gender:
 - Male
 - Female
 - Other

Self-Efficacy (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

5. I believe that I will earn at least a “C-” in my current mathematics course.
6. I am the kind of person who can succeed in mathematics.
7. I feel confident performing mathematical tasks.
8. I believe that I can complete all of the assignments in my mathematics course successfully.
9. I have set goals in my current mathematics course.

Faculty Interaction (Strongly Agree/Agree/ Neutral/No Opinion/Disagree/Strongly Disagree)

10. I feel comfortable approaching my mathematics instructor for assistance during class time.
11. My mathematics instructor cares about my progress in the course.
12. My mathematics instructor supports my progress in the course.
13. My mathematics instructor respects me.
14. My mathematics instructor acknowledges me.
15. My mathematics instructor is available for assistance outside of class time.
16. I have a good relationship with my mathematics instructor.

Academic Integration (Strongly Agree/Agree/ Neutral/No Opinion/Disagree/Strongly Disagree)

17. I work on math with other students outside of class time.
18. I am satisfied with the relevance of mathematics coursework to everyday life.
19. I can see how my math coursework relates to my intended major.

20. I am satisfied with the level of challenge presented to me in my current mathematics course.
21. I am aware of the academic resources provided by my mathematics instructor and the university.
22. I take advantage of academic resources that are available to me.

Psychosocial Integration (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

23. I view my mathematics discussion section as a community.
24. I feel I am an important member of my mathematics discussion section.
25. I feel a sense of belonging to my mathematics discussion section.
26. I know the names of at least a few of the other students in my current mathematics discussion section.
27. Other students in my math discussion section know who I am.
28. I feel isolated in my math discussion section.
29. I feel comfortable asking questions in my math discussion section.
30. I feel comfortable answering questions in my math discussion section.

Content Delivery Preferences (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

31. I prefer my mathematics course to be taught in a lecture format.
32. I prefer my mathematics course to be delivered in an online format.
33. I prefer my mathematics course to be delivered in a collaborative, group-work format.
34. I prefer my mathematics course to be delivered in a combination of online, lecture, and collaborative group work.
35. I like the way my current mathematics course is taught.
36. I am actively engaged in my current math course.
37. My current math course is taught in a way that helps me learn.

Classroom Climate (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

38. There is racial tension among students in my current mathematics class.
39. My current mathematics instructor has expressed stereotypes about racial or ethnic groups.
40. One or more students in my current mathematics class have expressed stereotypes about racial or ethnic groups.
41. One or more students in my current math class have expressed that I am not capable of doing well in the course.
42. My current math instructor has expressed that I am not capable of doing well in the course.
43. My current mathematics instructor has confidence in my ability to succeed in the course.
44. There is competition among students of different races or ethnic groups for high grades in my current mathematics class.

45. I feel as if I have been treated differently in my current mathematics class because of my race or ethnicity.

Critical Success Factors (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

The following are factors that may or may not be critical to your success in your current math course. (Options are Strongly Agree, Agree, Neutral/No Opinion, Disagree, Strongly Disagree)

- 46. Having a math instructor who is approachable is critical to my success in my math course
- 47. Having a math instructor who believes I can succeed is critical to my success in my math course
- 48. Having opportunities to work with other students on math during class is critical to my success in my math course
- 49. Having opportunities to work with other students on math outside of class is critical to my success in my math course
- 50. Feeling a sense of belonging in my discussion section is critical to my success in my math course
- 51. Having a comfortable and welcoming classroom environment is critical to my success in my math course
- 52. Being taught in a lecture format is critical to my success in my math course
- 53. Being taught in an online format is critical to my success in my math course
- 54. Being taught in a collaborative, group-work format is critical to my success in my math course
- 55. Having confidence in my abilities to learn mathematics is critical to my success in my math course

The following are factors that may or may not interfere with your ability to succeed in your current math course. (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

- 56. Feeling isolated in my discussion section interferes with my ability to succeed in my math course
- 57. Not feeling comfortable asking questions in my discussion section interferes with my ability to succeed in my math course
- 58. Racial tension in my discussion section interferes with my ability to succeed in my math course

Pedagogical Supports (Strongly Agree/Agree/Neutral/No Opinion/Disagree/Strongly Disagree)

- 57. Instruction that got me actively engaged in class would help me succeed in my math course
- 58. Instruction that included more lectures would help me succeed in my math course
- 59. Instruction that included more collaborative group work would help me succeed in my math course

60. Instruction that included more online components would help me succeed in my math course
61. Making the classroom more welcoming and comfortable would help me succeed in my math course
62. Improving racial relations in class would help me succeed in my math course
63. Making the classroom feel like a community where everyone belongs would help me succeed in my math course
64. Feeling comfortable asking my instructor for help would help me succeed in my math course

Free-response

65. Are you currently satisfied with your performance in your current math course? If yes, then what is the most important factor helping you be successful? If not, then what is the most important factor preventing you from being successful?
66. If you could make one change to your current mathematics course that would improve your success in the course, what would it be and why? Please explain.

Appendix B

INTERVIEW PROTOCOL

- 1.) Please tell me a little about yourself.
 - a. Probe: What made you choose UD?
 - b. Probe: What is your major? Why did you choose that major?
- 2.) Choose three words that describe yourself as a learner of mathematics.
 - a. Probe: Can you explain why you chose these words?
- 3.) What are your current attitudes towards mathematics?
 - a. Probe: Do you have any interest in mathematics?
 - b. Probe: Do you feel that you are successful in mathematics?
- 4.) Can you discuss your mathematics classroom “climate”?
 - a. Probe: On the survey, you reported feeling pretty (isolated/not isolated): can you speak more about this?
 - b. Probe: How do you think the community (your classmates) affects your performance in the class?
 - c. Probe: How do you think the community (if at all) could better support you to succeed in college math?
- 5.) Can you speak about your relationship with your current mathematics instructor?
 - a. Probe: How do you interact with your instructor?
 - b. Probe: How would you characterize your relationship?
 - c. Probe: How does your instructor affect your success in the course?
 - d. Probe: What could your current math instructor do to better support you to succeed in college math?
 - e. Probe: What kinds of relationships would you like to see UD math instructors developing with students in the future?
- 6.) “Microaggressions” can be defined as brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults towards people of color. To explore this concept further, please watch this short clip on microaggressions within a college campus setting:

Have you ever experienced discrimination, prejudice, or been the victim of microaggressions due to your race or ethnicity within a college mathematics setting? If so, could you describe what happened? How did you respond, if at all?

 - a. Probe: On the survey, you indicated that you felt that you had been treated differently in your mathematics classroom due to your race or ethnicity. Can you elaborate?

7.) What changes would you like to see and/or suggest in the mathematics classes at UD (specifically calculus courses) to better reach and teach all learners?

a. Probe: Outside of lecturing, have you experienced any different teaching delivery methods during high school or college?

b. Probe: Have you experienced any of these methods in a mathematics setting and/or here at UD?

c. Probe: How would you describe your ideal college math class? What kinds of teaching would you like to see implemented?

8.) What kinds of academic supports are you aware of that are available to you?

What kinds of academic supports would you find most helpful? (Academic supports include: Instructional technologies such as intelligent tutoring systems (ITS-ALEKS), tutorial videos online (Khan Academy), learning management system content provided by the instructor (Canvas and Sakai); Peer study groups; open courses on UD Capture; Tutoring and study skill courses at the Academic Enrichment Center)

Appendix C

IRB APPROVALS



RESEARCH OFFICE
210 HULLIHEN HALL UNIVERSITY OF DELAWARE
NEWARK, DELAWARE 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE: March 23, 2015

TO: Alexandra Reid, M.Ed.
FROM: University of Delaware IRB

STUDY TITLE: [674194-4] Examining the Differential Success of Underrepresented
Minority Students in Calculus Courses at the University of
Delaware
SUBMISSION TYPE: Amendment/Modification
ACTION: APPROVED
APPROVAL DATE: March 23, 2015
EXPIRATION DATE: January 13, 2016
REVIEW TYPE: Expedited Review

Thank you for your submission of Amendment/Modification materials for this research study. The University of Delaware IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office. Please note that all research records must be retained for a minimum of three years.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix D
SURVEY CONSENT FORM

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Title of Project: Examining the Differential Success of Underrepresented Minority Students in Calculus Courses at the University of Delaware

Principal Investigator(s): *Alexandra Reid, M.Ed.*

You are being invited to participate in a research study. This consent form tells you about the study including its purpose, what you will be asked to do if you decide to take part, and the risks and benefits of being in the study. Please read the information below and ask us any questions you may have before you decide whether or not you agree to participate.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to gain an understanding of the perceptions and attitudes of the calculus courses (MATH 221, MATH 241) offered at the undergraduate level at the University of Delaware by underrepresented minority students currently enrolled in them. The first phase of the study takes place in the form of a brief on-line survey. Student interviews will then be conducted in order to gain knowledge on what changes could be made to courses in order to hone student success; also, whether or not deficits in mathematics skills from the secondary level of education affect performance at the college level, and if so, to what extent. Data collected will be reported in an Executive Position Paper.

You will be one of approximately one hundred participants in this study. You are being asked to participate because...

You are an undergraduate student at the University of Delaware who is enrolled in one of the following courses: MATH 221, MATH 241.

You may be excluded from this study if you have never been enrolled in one of these courses. Successful completion (i.e. receiving a final grade of A, B, or C) of the course is not a requirement.

WHAT WILL YOU BE ASKED TO DO?

As part of this study you will be asked to.....

Complete an on-line survey. The results of this survey will be used to select possible candidates for one- on-one interviews later in the study.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

Possible risks of participating in this research study include

There are no physical risks to participating in this study. Participants will not be required to provide their names or any other identifiable information during the interview process. However, some of the questions

that will be asked as part of the study may cause you sadness or increase your level of stress while thinking of the answers.

WHAT ARE THE POTENTIAL BENEFITS?

You will not benefit directly from taking part in this research; however, the knowledge gained from this study may contribute to the understanding of ways to support the future success of underrepresented minority students in calculus courses at the University of Delaware.

HOW WILL CONFIDENTIALITY BE MAINTAINED? WHO MAY KNOW THAT YOU PARTICIPATED IN THIS RESEARCH?

Confidentiality will be maintained through the use of the assignment of security codes to the computerized survey results. If you are later selected and choose to participate in the interview process, the findings of this research may be presented or published. If this happens, no information that gives your name or other details will be shared.

The confidentiality of your records will be protected to the extent permitted by law. Your research records may be viewed by the University of Delaware Institutional Review Board, which is a committee formally designated to approve, monitor, and review biomedical and behavioral research involving humans. Records relating to this research will be kept for at least three years after the research study has been completed.

WILL THERE BE ANY COSTS TO YOU FOR PARTICIPATING IN THIS RESEARCH?

There is no cost to participate in this research.

WILL YOU RECEIVE ANY COMPENSATION FOR PARTICIPATION?

There will be no compensation for participation in this phase of the research.

DO YOU HAVE TO TAKE PART IN THIS STUDY?

Taking part in this research study is entirely voluntary. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are otherwise entitled. Your decision to stop participation, or not to participate, will not influence current or future relationships with the University of Delaware. As a student, if you decide not to take part in this research, your choice will have no effect on your academic status or your grade in the class.

If you choose to withdraw or not fully participate in the study, you must complete the alternative non- research assignment of equal value in order to receive the extra credit offered by your course instructor (if applicable).

The investigator may terminate subject participation if the subject is unable and/or unwilling to satisfactorily answer questions in the interview protocol. If, at any time, you decide to end your participation in this research study, please inform our research team by contacting the investigator via telephone or email.

WHO SHOULD YOU CALL IF YOU HAVE QUESTIONS OR CONCERNS?

If you have any questions about this study, please contact the Principal Investigator, Alexandra Reid, at (302) 981-4420, or alexreid@udel.edu; or Dr. Fred Hofstetter, at fmh@udel.edu.

If you have any questions or concerns about your rights as a research participant, you may contact the University of Delaware Institutional Review Board at hsrb-research@udel.edu or (302) 831-2137.

Your signature on this form means that: 1) you are at least 18 years old; 2) you have read and understand the information given in this form; 3) you have asked any questions you have about the research and the questions have been answered to your satisfaction; and 4) you accept the terms in the form and volunteer to participate in the study. You will be given a copy of this form to keep.

Printed Name of Participant	Signature of Participant	Date
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Person Obtaining Consent (PRINTED NAME)	Person Obtaining Consent (SIGNATURE)	Date
--	---	------

OPTIONAL CONSENT TO BE CONTACTED FOR FUTURE STUDIES:

Do we have your permission to contact you regarding participation in future studies? Please write your initials next to your preferred choice.

_____ YES NO _____

Appendix E
INTERVIEW CONSENT FORM

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Title of Project: Examining the Differential Success of Underrepresented Minority Students in Calculus Courses at the University of Delaware

Principal Investigator(s): *Alexandra Reid, M.Ed.*

You are being invited to participate in a research study. This consent form tells you about the study including its purpose, what you will be asked to do if you decide to take part, and the risks and benefits of being in the study. Please read the information below and ask us any questions you may have before you decide whether or not you agree to participate.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to gain an understanding of the perceptions and attitudes of the calculus courses (MATH 221, MATH 241) offered at the undergraduate level at the University of Delaware by underrepresented minority students currently enrolled in them. Student interviews will be conducted in order to gain knowledge on what changes could be made to courses in order to hone student success. Data collected will be reported in an Executive Position Paper.

You will be one of approximately one hundred participants in this study. You are being asked to participate because...

You are an undergraduate student at the University of Delaware who is enrolled in one of the following courses: MATH 221, MATH 241.

You may be excluded from this study if you have never been enrolled in one of these courses. Successful completion (i.e. receiving a final grade of A, B, or C) of the course is not a requirement.

WHAT WILL YOU BE ASKED TO DO?

As part of this study you will be asked to.....

Participate in a one-on-one interview. I would like to gain a better understanding of how you feel about your calculus course at the university. The interviews will take place at an on or off campus site of your convenience. Participants will be asked to participate in one interview, not to exceed one hour. Audio of the interview will be digitally recorded.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

Possible risks of participating in this research study include

There are no physical risks to participating in this study. Participants will not be required to provide their names or any other identifiable information during the interview process. However, some of the questions

that will be asked as part of the study may cause you sadness or increase your level of stress while thinking of the answers.

WHAT ARE THE POTENTIAL BENEFITS?

You will not benefit directly from taking part in this research; however, the knowledge gained from this study may contribute to the understanding of ways to support the future success of underrepresented minority students in calculus courses at the University of Delaware.

HOW WILL CONFIDENTIALITY BE MAINTAINED? WHO MAY KNOW THAT YOU PARTICIPATED IN THIS RESEARCH?

Confidentiality will be maintained through the use of code numbers, e.g., "Student 1". A document will be created which links participant identities to their code numbers. This document will be kept electronically on a secure server at the University of Delaware. As per IRB Regulations, audio recordings and electronic transcriptions of the interviews will be kept for three years, after which point the data will be destroyed. Audio recordings will be made available to research study personnel only. Data collected will be used in an Executive Position Paper. Direct quotes may be used in reporting through the use of the initial code numbers (e.g. "Student 1"). The findings of this research may be presented or published. If this happens, no information that gives your name or other details will be shared.

The confidentiality of your records will be protected to the extent permitted by law. Your research records may be viewed by the University of Delaware Institutional Review Board, which is a committee formally designated to approve, monitor, and review biomedical and behavioral research involving humans. Records relating to this research will be kept for at least three years after the research study has been completed.

WILL THERE BE ANY COSTS TO YOU FOR PARTICIPATING IN THIS RESEARCH?

There is no cost to participate in this research.

WILL YOU RECEIVE ANY COMPENSATION FOR PARTICIPATION?

You will receive a \$10 Barnes and Noble Gift Card for participation in this research study.

DO YOU HAVE TO TAKE PART IN THIS STUDY?

Taking part in this research study is entirely voluntary. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are otherwise entitled. Your decision to stop participation, or not to participate, will not influence current or future relationships with the University of Delaware. As a student, if you decide not to take part in this research, your choice will have no effect on your academic status or your grade in the class.

If you choose to withdraw or not fully participate in the study, you must complete the alternative non- research assignment of equal value in order to receive the extra credit offered by your course instructor (if applicable).

The investigator may terminate subject participation if the subject is unable and/or unwilling to satisfactorily answer questions in the interview protocol. If, at any time, you decide to end your participation in this research study, please inform our research team by contacting the investigator via telephone or email.

WHO SHOULD YOU CALL IF YOU HAVE QUESTIONS OR CONCERNS?

If you have any questions about this study, please contact the Principal Investigator, Alexandra Reid, at (302) 981-4420, or alexreid@udel.edu; or Dr. Fred Hofstetter, at fmh@udel.edu.

If you have any questions or concerns about your rights as a research participant, you may contact the University of Delaware Institutional Review Board at hsrb-research@udel.edu or (302) 831-2137.

Your signature on this form means that: 1) you are at least 18 years old; 2) you have read and understand the information given in this form; 3) you have asked any questions you have about the research and the questions have been answered to your satisfaction; and 4) you accept the terms in the form and volunteer to participate in the study. You will be given a copy of this form to keep.

Printed Name of Participant	Signature of Participant	Date
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Person Obtaining Consent PRINTED NAME)	Person Obtaining Consent (SIGNATURE)	Date
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OPTIONAL CONSENT TO BE CONTACTED FOR FUTURE STUDIES:

Do we have your permission to contact you regarding participation in future studies? Please write your initials next to your preferred choice.

_____ YES _____ NO