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“MAPPING THE MARGINS [IN MATHEMATICS]”: EXAMINING THE  
GENDERED AND RACIALIZED INTERSECTIONALITY OF MATHEMATICS  
EXPERIENCES AMONG AFRICAN AMERICAN AND LATIN@  
UNDERGRADUATE STUDENTS IN A LARGE, PREDOMINANTLY WHITE  
UNIVERSITY

by

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Dan Battey

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## ABSTRACT OF THE DISSERTATION

“Mapping the Margins [in Mathematics]”: Examining the Gendered and Racialized Intersectionality of Mathematics Experiences among African American and Latin@ Undergraduate Students in a Large, Predominantly White University

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Much extant research on gender in mathematics education has fallen short in distinguishing between gender and sex as well as attending to intersections of gender with other dimensions of identity such as race (Damarin, & Erchick, 2010; Esmonde, Brodie, Dookie, & Takeuchi, 2009; Rubel, 2016). Future work, therefore, is needed that couples a conceptualization of gender as a social construct with intersectional analyses to detail how the racialized masculinization of mathematics shapes differential opportunities for success among marginalized students (Leyva, accepted).

Drawing on post-structural theory and intersectionality (Crenshaw, 1991) from critical race theory, the purpose of this dissertation is to examine the gendered and racialized intersectionality of mathematics experiences among historically marginalized women of color and Latin@s pursuing math-intensive STEM majors at a large, predominantly white university. The following research questions guide this dissertation:

1. How has gender been studied in the field of mathematics education?

2. What strategies do historically marginalized women of color employ in navigating these gendered, racial, and intersectional discourses in making meaning of their mathematics success at intersections of gender and race?
3. In what ways do institutional structures and interpersonal relationships (both in and out of mathematics classrooms) afford or limit opportunities for mathematics success among undergraduate Latin@ engineering students?

Addressing these questions informs future directions for undergraduate mathematics education and higher education more broadly. This includes ways in which undergraduate mathematics classrooms and STEM support programs can serve as institutional spaces where gendered and racialized discourses of mathematics ability are taken up and challenged. In particular, this work's intersectional insights guide the development of relational mathematics instruction and sustained forms of institutional support to better address academic and social needs of STEM students marginalized at different intersections of identity (e.g., Latin@ women, queer people of color).

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## Dedication

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## Table of Contents

<b>Abstract of the Dissertation.....</b>	<b>ii</b>
Acknowledgments.....	iv
Dedication.....	vi
Table of Contents.....	vii
List of Tables.....	x
<b>Chapter 1: Introduction.....</b>	<b>1</b>
1. 1 Purpose and Research Questions.....	4
1.2 Overview of the Dissertation.....	5
<b>Chapter 2: Review of Research on Gender in Mathematics Education.....</b>	<b>14</b>
2.1 Introduction.....	15
2.2 Methods.....	17
2.3 Literature Review.....	25
2.3a Achievement Perspective.....	25
2.3b Participation Perspective.....	34
2.4 A Call for Intersectional Analyses of Gender.....	50
2.5 Discussion and Implications.....	58
<b>Chapter 3: Undergraduate Women of Color’s Mathematics Experiences.....</b>	<b>62</b>
3.1 Introduction.....	63
3.2 Literature Review.....	65
3.3 Theoretical Framework.....	72
3.4 Methods.....	76
3.5 Findings.....	87

3.5a Kelly.....	87
3.5b Rachael.....	94
3.5c Lauren.....	104
3.5d Tracey.....	112
3.5e Cross-Case Analysis of Mathematics Counter-Stories.....	121
3.6 Discussion and Implications.....	129
<b>Chapter 4: Mathematics Success among Undergraduate Latin@ Engineers .....</b>	<b>134</b>
4.1 Introduction.....	135
4.2 Literature Review.....	136
4.3 Theoretical Framework.....	138
4.4 Methods.....	139
4.5 Findings.....	145
4.5a Daniel.....	145
4.5b Brian.....	158
4.5c Cross-Case Analysis of Mathematics Counter-Stories.....	181
4.6 Discussion and Implications.....	185
<b>Chapter 5: Conclusion.....</b>	<b>188</b>
5.1 Findings and Significance.....	188
5.2 Implications for Research and Practice.....	190
5.3 Limitations .....	195
References.....	199
Appendix 1: Study 2 Focus Group Discussion Protocol.....	218
Appendix 2: Study 2 Representative Mathematics Classroom Seating Charts.....	221

## **List of Tables**

<b>Table 2.1</b>	Representative Examples of Achievement and Participation Perspectives.....	20
<b>Table 3.1</b>	Participant Profiles.....	79

## Chapter 1: Introduction

Research on gender in mathematics education experienced methodological and theoretical shifts over the past 45 years. Much of this extant work, however, has fallen short in distinguishing between the study of gender and sex such that the term *gender* has been problematically adopted to describe *sex* differences in mathematics performance and experiences between females and males (Damarin, & Erchick, 2010; Glasser & Smith, 2008; Rubel, 2016). Such conflations of gender and sex in documenting whole-group “differences” between women and men in mathematics are troubling. These “difference-as-deficit” views perpetuate long-standing assumptions of male superiority in mathematics and thus disallow agency among women, gender-nonconforming individuals, and other marginalized groups as well as dismiss the complexities of gender as socially constructed (Damarin & Erchick, 2010).

In light of such minimal considerations of within-group variation among women and men in mathematics, scholars have refined their methodological approaches by supplementing quantitative analyses of mathematics achievement with qualitative accounts of students’ gendered mathematics experiences. These adopted methodologies have included surveys, classroom observations, and student interviews that detailed variation in mathematics course enrollment and degree pursuits, mathematics ability beliefs, and teacher-student interactions in classrooms. Such more contextualized analyses use a conceptualization of gender from queer theory (Butler, 1990, 2004) – namely, a dynamic social construct performed differently by individuals across contexts – to closely examine the masculinization of mathematics that affects both women and men (Barnes, 2000; Mendick, 2006; Walshaw, 2001). Scholars’ more localized and relational

analyses of gender offered analytical insights into individual students' negotiations of their identities as responses to gendered mathematics experiences.

However, there remains analytical space in this body of work in attending to intersections of gender with other dimensions of identity including race and ethnicity that were left implicit or unexplored. Whiteness and geographical context, for example, have largely been excluded in these analyses of students' gendered mathematics experiences across studies conducted in different countries (Barnes, 2000; Boaler, 2002a; Mendick, 2006; Walshaw, 2001). Scholars are, therefore, calling for intersectional analyses that can nuance our understandings of marginalized populations' mathematics experiences studied by and large, thus far, in terms of gender and race as separate units of analysis (Esmonde et al., 2009; Martin 2009; Oppland-Cordell, 2014). Mathematics education research drawing on critical race theory (CRT) – a framework with intersectionality<sup>1</sup> (Crenshaw, 1991) as one of its tenets – attends to these intersections only in the race/sex sampling of participants such as African American males. However, race remains the primary focus with gender and other dimensions of identity left implicit in much of this CRT work's analyses of mathematics experiences among members of traditionally marginalized groups. Gender, therefore, is conceptualized as sex in much of this CRT scholarship with limited explorations of mathematics as a white, masculinized space and how this differentially impacts marginalized individuals at intersections of their gender, race, and other social identities.

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<sup>1</sup> Intersectionality is a theoretical perspective introduced by Crenshaw (1991) to address the mutual constitution of oppression at intersections of individuals' gender, race, and other dimensions of identity.

Future work, therefore, is needed that couples a conceptualization of gender as a social construct with intersectional analyses to detail how the racialized masculinization of mathematics shapes differential opportunities for success among underrepresented populations. Higher education scholars echo this need for intersectional scholarship to gain nuanced insights into African American and Latin@<sup>2</sup> students' strategies in navigating the gendered and racialized spaces of undergraduate STEM (science, technology, engineering, and mathematics) that map onto persistence, resilience, and success (Cole & Espinoza, 2008; Crisp, Nora, & Taggart, 2009; Espinosa, 2011; Solórzano, Ceja, & Yosso, 2000). This includes undergraduate mathematics where there have been recent calls for increased analytical attention to issues of equity and diversity in general (Adiredja, Alexander, & Andrews-Larson, 2015; Rasmussen & Wawro, under review). In this line of inquiry, this dissertation draws on insights from a review of research on gender in mathematics education (Chapter 2) for the adoption of intersectionality to guide analyses in two phenomenological studies (Chapters 3 and 4) on mathematics as a gendered and racialized experience among marginalized student populations at a large, predominantly white university. These two studies foreground the voices of African American women and Latin@s whose mathematics experiences remain

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<sup>2</sup> Drawing on Gutiérrez (2013), the term Latin@ decenters the patriarchal nature of the Spanish language that traditionally groups Latin American women and men into a single descriptor (Latino) denoting only men. The @ symbol allows for gender inclusivity among Latin Americans compared to the either-or form (Latina/o) implying a gender binary.

largely unexplored in the research literature (Joseph, accepted; Oppland-Cordell, 2014; Varley Gutiérrez, Willey, & Khisty, 2011).

### **1.1 Purpose and Research Questions**

Drawing on post-structural theory and intersectionality from CRT, the purpose of this dissertation is to examine the gendered and racialized intersectionality of mathematics experiences among historically marginalized women of color and Latin@s pursuing math-intensive<sup>3</sup> STEM majors at a large, predominantly white university in the northeastern United States. The following research questions guide this dissertation:

1. How has gender been conceptualized and studied in the field of mathematics education? To what extent has this work attended to intersections of gender with other dimensions of identity including race and ethnicity?
2. What are the most dominant gendered, racial, and intersectional discourses of mathematics ability that shape undergraduate African American and Latin@ women's mathematics experiences? What strategies do women of color employ in navigating these discourses and negotiating mathematics success at intersections of gender and race?
3. What institutional structures and interpersonal relationships (both in and out of mathematics classrooms) afford or limit opportunities for mathematics success among undergraduate Latin@ engineering students? How do Latin@ students

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<sup>3</sup> Math-intensive, in the context of this dissertation, is defined as STEM majors requiring at least two semesters of calculus based on the university's curriculum such as astrophysics, chemistry, computer science, engineering, mathematics, and physics.

negotiate gendered and racialized discourses to make meaning of their undergraduate mathematics success?

Addressing these questions informs future directions for undergraduate mathematics education and higher education more broadly to broaden participation and support for underrepresented populations in STEM. This includes ways in which undergraduate mathematics classrooms and STEM support programs can serve as institutional spaces where gendered and racialized discourses of mathematics ability are taken up and challenged. More specifically, the intersectional insights gained from this dissertation can guide the development of relational mathematics instruction and sustained forms of institutional support that address academic and social needs for student populations marginalized at different intersections of identity (e.g., Latin@ women, queer people of color).

## 1.2 Overview of the Dissertation

This dissertation addresses these research questions as follows. I begin with Chapter 2, a review of research that critically examines conceptual and methodological shifts in the study of gender in mathematics education (Leyva, accepted). This review grouped the research literature in two grounded categories based on theorizations and methodological approaches to studying gender: (i) *achievement* literature engages in sex-based comparisons between females' and males' mathematics performance and (ii) *participation* literature explores individuals' negotiations of their identities and practices in mathematics from either a sex-based or gender-based lens of analysis. As discussed earlier, analyses of gender at intersections with other dimensions of identity such as race are left implicit or unexplored in this reviewed literature. Thus, this review argues for



how intersectionality can complement the achievement and participation perspectives to gain more complex understandings of mathematics performance and experiences in relation to gender. By way of this review of research, I situate the two studies presented in Chapters 3 and 4 in the existing literature as works that address this lack of intersectional analyses by examining marginalized populations' gendered and racialized experiences in mathematics.

In Chapter 3, I report on findings from a phenomenological study exploring the mathematics experiences of four historically marginalized women of color in their first year as math-intensive STEM majors at a large, predominantly white university in the northeastern United States (Leyva, under review). Participants were two African American women and two Latin@ women affiliated with a STEM support program at the university who had taken at least one undergraduate mathematics course in their first semester. These participants were purposefully selected with the intent to capture at least some variation in their gendered and racialized mathematics experiences at these two intersections of gender and race – namely, woman/African American and woman/Latin@. Looking across participants' mathematics autobiographies as well as interview and focus group discussions, I used CRT and post-structural theory to guide the analytical construction of the four women of color's mathematics counter-stories<sup>4</sup> differentially shaped by gendered, racial, and intersectional discourses of mathematics ability and success.

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<sup>4</sup> Counter-stories, accordingly to Solórzano and Yosso (2002), are analytical constructions used in CRT methodology for “telling the stories of those people whose experiences are not often told (i.e., those on the margins of society)” (p. 32).

The most dominant discourses raised in the women of color's counter-stories included: (i) mathematics ability is innate, (ii) men are better than women in mathematics, (iii) African Americans and Latin@s are not good at mathematics, and (iv) Latin@ women are expected to become young mothers and wives. Using a three-tiered analytical framework to examine the women of color's mathematics experiences at institutional, interpersonal, and ideological levels, I documented how these discourses were encountered in the women's engagement with institutional structures (e.g., undergraduate mathematics teaching, university STEM support services) and interpersonal relations with teachers, peers, and families. A cross-case analysis examined the women of color's different strategies in navigating these discourses such as selectively sharing accomplishments, positioning themselves as exceptions, and building peer and family support networks. While the African American women discussed the emotional labor of managing the intersectional ambiguity of microaggressions in mathematics, the Latin@ women challenged the discourse of becoming young mothers and wives through a sense of responsibility to broaden opportunities in STEM for younger generations of Latin@s (including family members) vis-à-vis their undergraduate mathematics success.

Findings from this study informed the design of my second study presented in Chapter 4. This study was a case study phenomenology of mathematics success among two Latin@ women and three Latin@ men pursuing engineering majors at the same large, predominantly white university (Leyva, in preparation, in press). To focus the analysis and highlight variation across gendered and racialized mathematics experiences, the study findings reported in Chapter 4 attend to a single gender-race intersection

(namely, man/Latin@) and look across two Latin@ men participants' reflections and undergraduate mathematics classroom experiences.

I extended the work from the first study in two ways. First, I purposefully focused on Latin@s who have “seldom been asked for their perspectives on their classroom mathematics experiences” (Varley Gutiérrez et al., 2011, p. 27) and how they negotiate their multiple social identities with mathematics success. Latin@s, in particular, demonstrated an increase of nearly 75% in engineering degree completion over the last 15 years yet remain largely underrepresented in the field and STEM at large (National Science Foundation [NSF], 2015). With undergraduate mathematics including calculus serving as a critical filter for STEM-intending majors including engineering (Chen, 2013; Rasmussen, Marrongelle, & Borba, 2014), it is important to examine the extent to which undergraduate mathematics as a social experience both in and out of the classroom impacts Latin@s' retention and success in what Camacho and Lord (2014) call the “exclusionary space” of undergraduate engineering education. Thus, the second study builds on the first study by pursuing a more focused intersectional analysis using the same three-tiered analytical framework to examine undergraduate mathematics experiences among members of a single gender-race subgroup (Latin@ men) pursuing majors in the same math-intensive STEM discipline (engineering).

Second, a limitation of the first study was the lack of observations across undergraduate mathematics classrooms to complement participants' reflections of gendered and racialized engagement with instruction, faculty, and peers. Findings from the first study, however, illustrated how undergraduate mathematics classrooms were figured worlds in which the women of color observed gendered and racial discourses

shaping how teachers and peers positioned students as more or less mathematically able (Boaler & Greeno, 2000; Holland, Lachiotte, Skinner, & Cain, 1998). The women of color characterized such positioning along a gendered and racialized hierarchy of mathematics ability (Martin, 2009) in relation to differential opportunities for connecting with the mathematics content, building relationships with professors and graduate teaching assistants, and feelings of underrepresentation compared to high school. Building on these findings and addressing the first study's limitation, the second study coupled interview and focus group methodologies with yearlong classroom observations to gain situated insights into the Latin@ engineering students' participation in undergraduate mathematics spaces and its influences on the co-construction of positive academic and social identities (Oppland-Cordell, 2014). Such ethnographic methodology allowed for detailing the institutional space of undergraduate mathematics classrooms including the nature of instruction, teacher-student interactions, and focal Latin@ participants' engagement (Battey & Leyva, 2015b, under review; Esmonde & Langer-Osuna, 2013; Moore, 2008). The coupling of observation data with stimulus-recall reflections on potentially critical classroom moments during interviews and a focus group discussion allowed for examining Latin@ participants' *identities-in-practice* (Lave, 1996) in terms of how they received, interpreted, and were possibly impacted by these instances (Ericsson & Simon, 1993). Furthermore, re-visiting classroom observation data across interview and focus group spaces also provided analytical insight into "breaches" (Herbst & Chazan, 2011) of the undergraduate mathematics classroom experience in relation to students taking up space (Hand, 2003), the influence of gendered and racial discourses of mathematics ability (Shah, under review), and quality of teacher-student

relationships (Battey, 2013b; Battey, Neal, Leyva, & Adams-Wiggins, 2016; Battey & Leyva, 2013, 2015a).

In Chapter 4, I present findings from the second study detailing mathematics success as a gendered and racialized phenomenon among two Latin@ men pursuing engineering majors at a large, predominantly white university. Participants were purposefully selected based on criteria informed by extant work on “successful” underrepresented students in STEM (Cole & Espinoza, 2008; McGee & Martin, 2011; Stinson, 2008). Both Latin@ men were affiliated with the university’s chapter of the Society of Hispanic Professional Engineers (SHPE), a national organization aimed at empowering the Hispanic community in realizing its potential in engineering through STEM outreach and professional networking. Latin@ critical race theory, a “close cousin” to CRT, was adopted to closely examine the intersectionality of the Latin@ men’s mathematics experiences in relation to issues of culture, immigration, and language specific to Latin@s that often go unaddressed under CRT (Bernal, 2002). Layering the first study’s CRT methodology and post-structural analyses of mathematics counter-stories, I completed yearlong field observations in the Latin@ men’s undergraduate mathematics classrooms including three 80-minute lectures led by a mathematics faculty member as well as three 80-minute recitations (or problem-solving sessions) led by a graduate teaching assistant per academic semester. These observations, as previously mentioned, detailed the instructional and relational spaces of the Latin@ men’s undergraduate mathematics classrooms as well as participants’ forms of engagement across these contexts. Stimulus-recall of mathematics classroom observations during interviews and a focus group discussion offered insight how

participants made meaning of these experiences in negotiating their identities with mathematics success as Latin@ men.

Findings from this phenomenological work corroborate those from the first study in terms of how marginalized populations (in this case, Latin@ men) must adopt strategies in successfully navigating undergraduate mathematics and STEM more broadly as a white institutional space (Battey & Leyva, 2015b, under review; Martin, 2013). These strategies mapping onto the Latin@ men's mathematics success as engineering majors included: (i) establishing peer networks for academic and social support across university STEM spaces (e.g., SHPE meetings, engineering student orientation), (ii) building relationships with mathematics faculty characterized by notions of receiving *apoyo* (moral support; Auerbach, 2006) and *consejos* (cultural narratives of advice; Delgado-Gaitan, 1994) in Latin@ culture, and (iii) managing risks of participation across undergraduate mathematics classrooms discursively racialized by discourses of mathematics (or academic) success (e.g., whites and Asians are naturally good at math, Latin@ men do not go to college and instead pursue vocational jobs or the military after high school).

Cutting across these strategies in the Latin@ men's pursuits of mathematics success is the concept of *familismo* (Sáenz & Ponjuan, 2009), or sense of loyalty and responsibility to the Latin@ family unit. At the institutional level, the Latin@ men expressed how it "feels like home" to be a part of SHPE meetings and study groups with an accountability to support peers who look like another with STEM coursework and, in turn, "feel like [they] belong" at the university. Interpersonally, the Latin@ men reflected on how the most meaningful aspect of relationships with faculty who influenced

their undergraduate mathematics success was the family-like nature of their support. Such support was both academic and moral as the faculty members were not just approachable and accessible in providing coursework assistance, but also extended moral pieces of advice in being successful and persevering as Latin@s in STEM likened to the *apoyo* and *consejos* that Latin@ children receive from their parents in relation to education. At the intersections of their gender and racial identities, the participants expressed motivation of challenging intersectional discourses of Latin@ men not associated with success in STEM and higher education more broadly. Similar to the Latin@ women in the first study, the Latin@ men expressed feeling either an “obligation” to use this success in making their parents proud of their STEM academic and professional accomplishments or a sense of responsibility to inform those in their hometown about how to be successful in STEM at a four-year university. This maps onto the notion of *obligación* in the Latin@ culture characterized as a moral imperative to pursue action (in this case, mathematics success as engineering majors) for the advancement of Latin@ families and/or the Latin@ community at large.

In Chapter 5, I offer concluding thoughts on the dissertation. The chapters in this dissertation collectively expand the field of mathematics education’s conceptual and methodological approaches to studying mathematics as a social experience among students marginalized at intersections of gender, race, and other dimensions of identity. Findings from the study in Chapter 3 point to the need of scholarship that examines how institutional spaces of undergraduate STEM education, including mathematics classrooms and support programs, shape marginalized students’ gendered and racialized intersectionality of mathematics experience. By layering this study’s methodology with

classroom observations, the second study presented in Chapter 4 advances post-hoc analyses of mathematics identities in the research literature to characterize the dynamic interplay of individual students' experiences with the white, masculinized institutional contexts of mathematics and, more specifically, undergraduate mathematics education. By situating these mathematics identities-in-practice as constructs negotiated with the institutional fabric of undergraduate STEM education, this dissertation sheds light on ways to advance institutional change in higher education that closely attends to intersections of marginalized populations' identities and thus broadens opportunities for more inclusive social support for students in navigating the gendered and racialized spaces of undergraduate mathematics education and STEM education more broadly.



## **Chapter 2: Male Superiority to Masculinization -- A Review of Key Research on Gender in Mathematics Education**

### **Abstract**

Gender research in mathematics education experienced methodological and theoretical shifts over the past 45 years. While achievement studies used assessment tools to explore and subsequently challenge the assumption of male superiority in mathematics, later research unpacked these studies' female-male statistical comparisons by exploring the masculinization of mathematics participation through qualitative methods. This article offers a review of gender scholarship in mathematics education with analysis of its findings as well as conceptual and empirical contributions. Current understandings of mathematics as a gendered space, however, can be further broadened through intersectional analyses of gender and its interplay with other identities (e.g., race, class). Implications for future gender research, particularly the adoption of intersectionality (Crenshaw, 1991), are raised to inform more nuanced analyses.

**Keywords:** intersectionality, achievement, participation, identity

## 2.1 Introduction

Past educational research on issues of gender and sex has largely fallen short in providing clear, theoretically-grounded definitions of adopted terminology. In *Educational Researcher*, Glasser and Smith (2008) addressed the “pattern of unclear, conflated, and even synonymous use” (p. 343) of *gender* and *sex* observed in educational research as well as called for future scholars’ increased clarity in their conceptualizations of gender. Mathematics education research is no exception as noted in its by-and-large problematic use of gender to describe sex-based differences in mathematics performance between females and males (Damarin & Erchick, 2010). This conceptual drawback in not distinguishing between gender and sex, according to Damarin and Erchick (2010), is particularly troubling for the future of mathematics education research as its “difference-as-deficit” views perpetuate long-standing assumptions of male superiority in mathematics that disallow agency among women and other marginalized groups as well as dismiss the complexities of gender as a social construct.

In light of such limited considerations for within-group variation among women and men in mathematics, some gender equity scholars in mathematics education have refined their research approaches by supplementing statistical analyses of mathematics performance differences with qualitative accounts of students’ experiences in school mathematics. Such contextualized analyses use a conceptualization of gender from queer theory (Butler, 1990, 2004) – namely, a dynamic social construct performed differently across contexts and individuals – to closely examine how mathematics is a site of masculinization as opposed to one of male superiority. Scholars’ more localized and

relational analyses of gender offered insights into students' negotiations of their identities as responses to gendered mathematics experiences.

In this review, I synthesize gender research in mathematics education that offers different theoretical perspectives and methodological approaches to understanding the gendered influences on opportunities for mathematics success. The purpose of this literature review is to present a critical analysis that highlights various research studies' respective contributions and methodological limitations to inform subsequent scholarship on gender and mathematics. Furthermore, this review argues that intersectionality (Crenshaw, 1991) from critical race theory (CRT) can effectively complement insights from these existing research perspectives in the pursuit of more nuanced analyses of mathematics as a racialized, gendered, and overall social experience. Implications for future research on gender equity and mathematics education are raised at the conclusion of the review.

As per scholars' recommendations of clearly defining key terminology in educational research (Damarin & Erchick, 2010; Glasser & Smith, 2010), some insight on the following review's adopted terms regarding gender and race are in order. My analysis of the literature draws on poststructuralist and queer theories (Butler, 1990, 2004; Wilchins, 2004) in defining gender as discursive productions that vary across individuals and are subject to change in different contexts. This conceptualization informs my use of the terms, women and men as well as girls and boys, when referring to gender instead of the biological sex categories, females and males, throughout the literature review. However, when discussing extant scholarship in mathematics education, I maintain the authors' original choice of terms unless stated otherwise.

Drawing on Ladson-Billings & Tate (1995), I define *race* as a social construct that intersects with property rights to capture the societal inequities (including education) in the United States for people of color. The adopted definitions of gender and race, in turn, are used to argue for the future adoption of intersectional lenses of analyses of gender in mathematics education research.

## 2.2 Methods

Drawing on Weaver-Hightower's (2003) literature review methodology, this review groups the gender research literature into two grounded categories according to their conceptual and methodological approaches in studying gender and mathematics. These categories include: (i) *achievement* literature that draws sex-based comparisons of females and males' mathematics ability and (ii) *participation* literature that explores students' sociocultural negotiations of their identities and practices in mathematics from either a sex- or gender-based lens of analysis.

I caution readers that this is a comprehensive but not exhaustive review. It does not include every scholarly work on gender in mathematics education. A diligent attempt, however, was made to develop a comprehensive analysis of key studies that made notable contributions to advance theoretical and empirical explorations of gender in the field. First, a general search for empirical research studies in mathematics education on issues of sex and gender was completed. An analysis of the search results' conceptual and methodological approaches to studying gender was completed leading to the development of the achievement and participation categories for grouping the search results accordingly. The achievement category grouped research studies that adopted sex-based, statistical analyses of female-male differences in mathematics ability across

different assessments. Studies under the participation category contextualized mathematics achievement findings using qualitative methodologies that detailed students' mathematics experiences (e.g., teacher-student interactions, classroom engagement, subject choice) from either a sex- or gender-based lens of analysis. Table 1 presents specific examples of these two research perspectives on gender in mathematics education as well as their number of scholarly citations on Google Scholar as of October 2014, analytical focus, study contexts, and participant profiles.

It should also be noted that the literature reviewed here was purposefully selected as exemplary research studies that not only make explicit the characteristics of the two perspectives, but also influenced the field of mathematics education as per the noted number of citations. Thus, these representative texts considered in the review are used to trace the intellectual development of gender as an area of focus in mathematics education research. No gender equity scholarship in mathematics education was deliberately excluded in light of their conceptual development, methodological approach, and political stance. Therefore, the achievement and participation categories make up a grounded scheme to thematically organize the literature for the purposes of this review.

The following section presents a review of the achievement and participation perspectives that both highlights and critiques their respective contributions to the study of gender in mathematics education. More specifically, I examine the theorization of gender as well as the adopted data collection and analysis techniques across the two bodies of research literature in mathematics education. Variation in the conceptualization and empirical study of gender within these research perspectives is also considered. The review then presents an analysis of how theoretical and methodological use of

intersectionality (Crenshaw, 1991) from critical race theory complements the achievement and participation perspectives to allow for mathematics educators' more nuanced analyses of gender.

**Table 2.1***Representative Examples of Achievement and Participation Perspectives*

<b>Perspective</b>	<b>Examples (* denotes representative texts in review)</b>	<b>Number of Citations</b>	<b>Context</b>	<b>Analytical Focus</b>	<b>Study Participants</b>
<b>Achievement Literature</b>	Hilton & Berglund (1974)*	219	United States (U.S.)	Sex differences in test scores	978 females and 881 males in academic and non-academic tracks between fifth and eleventh grades
	Fennema & Sherman (1977)*	958	4 predominantly white high schools across U.S.	Sex differences in test scores and Fennema-Sherman Mathematics Attitude (FSMA) Scales	589 females and 644 males
	Guay & McDaniel (1977)	101	U.S. elementary schools	Sex differences in 4 researcher-developed tests on spatial ability	90 children between the ages of 14 and 16
	Sherman & Fennema (1977)	195	U.S.	Sex differences in test scores (math, verbal ability, spatial ability) and 8 FSMA Scales	716 tenth- and eleventh-grade students
	Fennema & Sherman (1978)	498	Predominantly white, middle-class middle schools in Madison, Wisconsin	Sex differences in problem solving, vocabulary, spatial ability, and FSMA Test	1320 sixth- to eighth-grade students representative of top 85% in math achievement

Fennema & Carpenter (1981)*	121	U.S.	Sex differences on National Assessment of Educational Progress	70,000 children of the ages 9, 13, and 17
Hanna (1986)	39	Ontario, Canada	Sex differences on pre- and post-test performance in 174 items from Second International Mathematics Study (SIMS) of the International Association for the Evaluation of Educational Achievement	1750 females and 17773 males in eighth grade
Hanna (1989)*	59	20 countries between 1982 and 1983	Sex differences on SIMS	37043 females and 37410 males in eighth grade
Fennema, Carpenter, Jacobs, Franke, Levi (1998)*	693	3 elementary schools in the U.S.: - Rural, predominantly white with 4% free or reduced lunch - Predominantly white with 26% free or reduced lunch - Predominantly white with 8% free or reduced lunch	Sex differences mathematics strategy use on researcher-developed problem solving test	44 males, 38 females (89% white, 11% free or reduced lunch)



<b>Participation Literature</b>		Leder, Forgasz, & Taylor (2006)	69	Victoria, Australia; 2002-2004	Sex differences in data on Australian Mathematics Competition (AMC) and Victorian Certificate of Education (VCE)	Twelfth-grade student AMC and VCE participants
	<b>Sex-Based</b>	Becker (1981)	243	2 U.S. elementary schools: <ul style="list-style-type: none"> <li>• Urban-suburban with well-educated and relatively affluent population</li> <li>• Rural near city located 50 miles from large metropolitan area</li> </ul>	Sex differences in mathematics teacher treatment using Brophy-Good Teacher-Child Dyadic Interaction System	10 high school geometry teachers (7 females, 3 males)
				3 high schools in the U.S.		
		Peterson & Fennema (1985)	231	15 schools in rural area or small towns near large cities; Predominantly white and middle class	Sex differences on low and high NAEP item performance as well as (non-)engagement in classroom activities (competitive, cooperative, social, off-task)	6 randomly-selected females and 6 randomly-selected males across 36 fourth-grade mathematics classes (3 females, 33 males)

Hart (1989)	82	Spring 1980 in the U.S.	Sex differences in mathematics-teacher student interactions across confidence levels using modified Brophy-Good Dyadic Observation System	93 seventh-grade mathematics students (20 high-confidence females, 25 low-confidence females, 24 high-confidence males, 24 low-confidence males); 6 teachers with 5-10 target students in each class
Fennema, Peterson, Carpenter, & Lubinski (1990)*	201	24 U.S. elementary schools	Sex differences in teachers' attributions and beliefs of student mathematics ability	38 first-grade, female teachers; 314 females and 368 males
Forgasz & Leder (1996)	65	3 school sites in Melbourne, Australia: <ul style="list-style-type: none"> <li>• 35 seventh-grade classes across Victorian co-educational, post-primary schools</li> <li>• 2 seventh-grade classes from co-educational secondary schools</li> </ul>	Sex differences in mathematics affect	396 female and 386 male post-primary students for survey  2 female and 2 male students as targets from each secondary school's seventh grade class
Boaler (2002a)*	929	2 school sites in England of working-class status (Amber Hill and Phoenix Park)	Sex differences in mathematics learning between traditional and reform mathematics teaching approaches	Students between ages 13-16 across all ability tracks (Sets 1-4) at Amber Hill and all 5 mixed-ability tracks in Phoenix Park

	Tiedemann (2002)	70	2 randomly- selected, predominantly white, and middle- class German town and country schools	Sex differences in mathematics teacher perceptions of students	48 teachers; 288 third- and fourth-grade students
<b>Gender -Based</b>	Barnes (2000)*	18	Independent co- educational school in Australia	Gendered collaborative learning experiences in mathematics class	22 students (15-16 years old) in accelerated Year 10 math class
	Mendick (2006)*	132	3 postsecondary schools: - Ethnically diverse, working class (Grafton) - Ethnically diverse, middle class with academic curriculum (Westerburg) - International, non- traditional student population with vocational, part- time curriculum (Sunnydale)	Gendered experiences with post-secondary mathematics subject choice	43 post-secondary students aged between 16 and 19 pursuing mathematics

## 2.3 Literature Review

### 2.3a Achievement Perspective

Early research on gender in mathematics education can be considered to use an *achievement* lens characterized primarily by comparisons of females and males' mathematics performance. These research studies employed a wide range of assessment instruments to statistically measure female and male students' mathematics achievement such as standardized test scores as well as international and national mathematics studies (Fennema & Carpenter, 1981; Fennema & Sherman, 1977, 1978; Guay & McDaniel, 1977; Hanna, 1986, 1989; Hilton & Berglund, 1974; Leder, Forgaz, & Taylor, 2006; Sherman & Fennema, 1977). Largely motivated by further exploring the assumption of males' innate superiority in mathematics, early achievement study findings consistently challenged this sex-based innateness of mathematics ability with negligible performance differences between females and males in early grades (Fennema & Carpenter, 1981; Fennema & Sherman, 1977; Hilton & Berglund, 1974). The sex-based disparity noted in mathematics achievement and interest during later grades raised scholars' considerations of contextual influences (e.g., classroom, cultural norms, curriculum) that may differentially impact females and males' mathematics performance and experiences. Reform explorations of mathematics learning also brought later achievement studies to supplement statistical analyses with qualitative methodologies including interviews and longitudinal tracing of reasoning in mathematics problem solving (Fennema, Carpenter, Jacobs, Franke, & Levi, 1998).

Despite these methodological advances, gender remained conceptualized as being the same as an individual's biological sex – namely, either female or male – which does

not include intersex and gender non-conforming people as well as reifies the idea that there are two distinct biological groups of people. This early theorization of gender and long-standing assumption of male superiority in mathematics, as a result, resulted in analyses that left implicit varying social influences on students' achievement and instead largely focused on statistical trends to explain female-male performance differences in mathematics. These comparisons of female and male groups in achievement studies, therefore, led to homogenizing claims of mathematics ability with room for further consideration of within-group variation in terms of race and class as well as contextual influences of different mathematics learning environments.

In the following sections, I examine how the theorization of gender as synonymous with sex in the achievement literature resulted in statistical searches for underlying causes of female-male disparities in mathematics achievement and task performance. These sections also highlight how the emergence of such sex differences in mathematics achievement during later grades set the stage for future gender research to unpack these statistical findings in relation to contextual factors and student experience in mathematics. To accomplish this, I draw upon research studies from Hilton & Berglund (1974), Fennema et al. (1977, 1981, 1998), and Hanna (1989) that trace the theoretical and empirical development of the achievement perspective for studying gender in mathematics education.

**Detailing sex differences in mathematics.** By treating research subjects' sex or "gender" classifications as independent variables, the achievement studies examined sex(-related) differences (Hilton & Berglund, 1974; Fennema & Carpenter, 1981; Fennema & Sherman, 1977, 1978; Guay & McDaniel, 1977; Hanna, 1986, 1989;

Sherman & Fennema, 1977) or “gender” differences (Fennema et al., 1998; Leder et al., 2006) in mathematics achievement and task performance. Such investigations for the underlying causes of sex-based differential achievement were largely motivated by the long-standing yet problematic assumption of males’ innate mathematical superiority over females (Fennema, 1979). The achievement studies, thus, used empirical evidence of sex-based group differences to draw statistical causal inferences regarding subjects’ sex and their mathematics ability. However, much of these findings challenged the notion of male mathematical superiority and thus called for future considerations of sociocultural and other contextual influences on achievement.

Early dichotomous female-male theorizations of gender in achievement studies largely informed the comparative nature of data collection and analyses on mathematics ability. Hilton & Berglund (1974), for example, investigated females and males’ performance differences on mathematics sections of the Sequential Test of Educational Progress and School and College Ability Test between fifth and eleventh grades. Students’ mathematics interest was measured using the Background and Experience Questionnaire (BEQ) that collected information on students’ in- and out-of-school mathematics experiences. Upon examining sex-differences across student groups enrolled in academic (or college preparatory) and non-academic school tracks, Hilton & Berglund (1974) found statically-significant differences between females and males’ mathematics performance and interest after fifth grade particularly for the academic group. A noteworthy BEQ finding was that the largest disparity in perceived future utility of mathematics was between the academic group’s females and males during eleventh grade. Despite Hilton & Berglund’s (1974) observed statistical trends of

divergence in mathematics achievement and interest during advanced grade levels, they were unable to offer any causal conclusions on whether high interest precedes high achievement in mathematics or vice versa.

**Problematizing male superiority in mathematics.** Like Hilton & Berglund's (1974) longitudinal assessment study, later achievement scholarship from Fennema & Sherman (1977) and Fennema & Carpenter (1981) also observed negligible sex differences in mathematics performance during early grades and when controlling for mathematics background among high school students. Sex-based disparities in mathematics achievement and interest, instead, were found to significantly widen during students' adolescent years with males outperforming their female counterparts on assessments of higher cognitive demand and advanced mathematical concepts. Such consistent findings contributed evidence to deficit-based views on females as mathematics learners observed in subsequent gender equity publications such as references to "the girl problem in mathematics" (Campbell, 1995). But more importantly, these findings put into question the extent to which contextual factors and social experience in mathematics serve as gendering mechanisms giving rise to these sex differences that were negligible or absent during participants' early years.

Fennema's work with Sherman (1977), thus, set the stage in challenging the notion of males' innate mathematical superiority by calling for sociocultural considerations of mathematics achievement in light of school-to-school variation across their participants' task performance. Hanna (1989) similarly problematized narratives of females' mathematics deficiencies through her international study that examined 70,000 eighth grade students' mathematics assessment score differences across twenty countries

including the United States. This study's cross-cultural lens of analysis on sex-based performance differences introduced sociocultural perspectives on mathematics achievement unexplored in earlier scholarship. When factoring in country and country-by-sex variables, a two-way multivariate analysis on achievement was found to be statistically significant. Hanna (1989), in turn, used these statistical findings to address how sex differences in mathematics achievement can vary internationally due to cultural influences on curriculum development and social norms for learning. Therefore, this work's social considerations of mathematics achievement problematized the long-standing assumption of males' innate mathematical superiority – an idea that framed much of the early achievement literature's statistical studies of sex differences in mathematics.

Thus, Hanna's (1989) study findings pointed to the minimal consideration for within-group variation among compared groups of females and males across achievement studies. The interaction between students' sex and country of origin offered more nuanced explanations of sex-based mathematics achievement differences that would not have been possible with sex as the only variable in the analysis. Looking back on early gender scholarship in mathematics education prior to Hanna's (1989) study, Fennema (2000) described how the field was in need of more complex theoretical lenses that consider the intersections of gender and other social identities in mathematics achievement, "The U.S., as many other countries, is a highly heterogeneous society, made of many layers, divisions, and cultures. The pattern of female differences in mathematics varies across these layers and must be considered" (p. 6). It is, therefore, critical that scholars carefully attend to the intersections of students' identities including



race, class, and gender to establish more complete understandings of the social variations in mathematics achievement and experiences.

**A cognitive turn in gender research.** Achievement studies often used the term gender as synonymous to sex in its conceptualization as the inherent, biological trait that distinguishes between female and male participants. Fennema et al. (1998), for example, took up the notion of males' mathematical superiority for further analysis in their longitudinal study of "gender differences" between girls and boys' problem solving. Although Fennema et al. (1998) claimed gender to be the analytical focus on young children's differences in mathematics thinking, their study pursued a sex-based analysis much like prior achievement studies with dichotomous comparisons of girls' and boys' problem solving approaches. This sex-based analysis in Fennema et al.'s (1998) longitudinal study explains why I purposefully use the terms, females and males, when referring to the boy and girl participants throughout the review. While re-affirming past achievement findings through a noted year-to-year absence of early female-male differences in mathematics assessment performance, Fennema et al. (1998) went further and argued that "gender differences" in more advanced mathematics can be explained by females and males' distinct problem solving approaches – namely, males' more frequent use of abstract strategies leading to greater success with complex problem solving tasks compared to females. While the extrapolation that these problem solving strategies are distinctively adopted by either females or males is worth further exploring in terms of what mechanisms produce such differences, Fennema et. al.'s (1998) findings were insightful in terms of raising initial considerations of gendered performances in doing mathematics.

Fennema et al.'s (1998) longitudinal study, at the same time, represented a turning point in gender scholarship through its reform considerations of mathematics learning unlike preceding achievement studies' focus on test score differences. These researchers used a problem-solving assessment tool aligned with participants' school mathematics curricula as well as a series of cognitive interviews to probe students' reasoning for their solution strategies. In contrast to standardized tests used in prior achievement research, the researcher-developed assessment and interviews were methodological affordances that not only took into account participants' past curricular exposure to mathematics topics, but also allowed for explorations of mathematical reasoning and strategy development over three years.

The cognitive study effectively introduced learning perspectives to the realm of gender research in mathematics education, but other scholars have noted how the lack of insights within participants' mathematics learning and teaching environments (e.g., classrooms) remained an analytical drawback (Boaler, 2002c; Hyde & Jaffe, 1998; Sowder, 1998). More specifically, Boaler (2002c) argues that Fennema et al. (1998) offered minimal detail on the mathematics teaching and learning practices that contextualized the nature of students' classroom interactions as opposed to "position[ing] gender as a characteristic of groups of people, rather than a situated response" (p. 22). Hyde & Jaffee's (1998) solicited critique on Fennema et al.'s (1998) longitudinal study from a social and feminist psychological perspective also asserted the need for mathematics classroom observations to consider how individual females and males responded similarly *and* differently to the mathematics. In alignment with these scholarly critiques, Fennema (2000) later acknowledged these limitations and described

how such studies on “gender differences” like the longitudinal study often presented an “incomplete picture” that overlooked complex variations in individuals’ learning experiences including the gendered socialization of mathematics classrooms. These developments in the achievement scholarship on gender in mathematics education, thus, further challenged the discourse of male superiority and shed light on social nuances of context and identity that need to be actively considered in future research.

***Research implications from achievement perspective.*** For over 30 years, achievement studies demonstrated significant methodological shifts that provided promising templates for more nuanced explorations of mathematics inequities in future gender research. Boaler (2002c) wrote, “An important responsibility of gender researchers in the future will be to build upon our predecessors’ work and search for explanations of the differences they found, not within the nature of girls, but within the interactions that produce gendered responses” (p. 149). Earlier achievement work raised considerations for further research in exploring the connections between students’ mathematics achievement and interest as well as how gendered experiences in school mathematics (e.g., tracking, curricula, classroom norms) may influence the nature of these relationships (Fennema, 1974; Fennema & Carpenter, 1981; Hilton & Berglund, 1974). In the meantime, research studies like Hanna’s (1989) cross-cultural analysis of international students’ mathematics performance highlighted the social complexities of differential academic outcomes that can be better understood by examining within-group variation among females and males.

Fennema et al.’s (1998) cognitive study supplemented statistical findings with qualitative methodologies (e.g., cognitive interviews) allowing for reform considerations

of learning and preliminary insights into gendered performances of doing mathematics that, in turn, broadened the achievement perspective's empirical approaches to studying gender. However, it is also left implicit to consider how Fennema et al.'s (1998) longitudinal study findings generalize from the participant population. Thus, a more diverse student sampling in future studies building on Fennema et al.'s (1998) methodology would allow for considerations at the intersections of sex, race, and class with the possibility of finding variation among females' mathematics problem solving strategies.

At the same time, achievement studies also held conceptual and methodological limitations particularly with their theorization of gender as a female-male binary as well as decontextualized analyses of mathematics engagement. Boaler (1997) criticized implications from achievement research as inequitably contributing to the masculinization of norms for mathematics success. More specifically, Boaler (1997) argued that emerging discourses of girls' weaker mathematics performance are unfairly suggestive of "ways in which girls should change, ways in which they should become less anxious, more confident; in essence, more *masculine*" (p. 1, emphasis added).

With possible connections between mathematics achievement and gendered forms of valued engagement in mathematics, scholars faced the task of exploring whether gender inequities rested in the masculinization of mathematics as opposed to traditional assumptions of male superiority. Calls for more individualized, situated analyses of students' mathematics experiences conceptually and methodologically set the stage for research exploring gender from a *participation* perspective. These participation studies aligned with Boaler & Greeno's (2000) framing of mathematics participation as the social

and personal negotiations of meaning that shape individuals' identities and practices in mathematics.

### 2.3b Participation Perspective

From this framing, mathematics classrooms are figured worlds (Holland et al., 1998) in which students' participation is subject to peers and teachers' gendered interpretations that in turn shape their mathematics identities (Barnes, 2000; Esmonde & Langer-Osuna, 2013). Boaler & Greeno (2000) wrote, "Participation in social practices is what learning mathematics is. The social practices of a community provide an environment in which students can participate, and their ways of participating are adaptations to the constraints and affordances of the environment" (p. 173). This section of the review organizes the research literature explored from a *participation* analytical perspective into two sub-categories based on their theorizations of gender including *sex-based* participation studies (Becker, 1981; Boaler, 2002a; Fennema, Peterson, Carpenter, & Lubinski, 1990; Forgasz & Leder, 1996; Hart, 1989; Peterson & Fennema, 1985; Tiedemann, 2002) and *gender-based* participation studies (Barnes, 2000; Mendick, 2006).

**Sex-based participation: Gendering sociomathematical norms<sup>5</sup>.** Sex-based participation studies explored how students' interactions in different mathematics

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<sup>5</sup> Yackel and Cobb (1996) define *sociomathematical norms* as the "normative understandings of what counts as mathematically different, mathematically sophisticated, mathematically efficient, and mathematically elegant in a classroom" (p. 461). These norms, in turn, are relationally produced and negotiated to establish interpretations of who is "intellectually autonomous in mathematics" (p. 458).

learning contexts led to gendered experiences in being academically successful. Despite this shift in the research agenda with consideration of contextual influences on gender inequities in mathematics, the sex-based participation literature continued to use the dichotomous female-male conceptualization of gender in its data analyses similarly adopted in achievement studies. This sex-based analysis informs the review's purposeful adoption of the terms, females and males, as participant descriptors instead of the participation scholars' original use of girls and boys. The following section explores insights from two sex-based participation research studies that highlight how teacher beliefs and school curricula contributed to the gendering of sociomathematical norms. In particular, I argue how Fennema et al. (1990) and Boaler's (2002a) research studies captured the establishment of gendered hierarchies of mathematics ability that impacted students' participation and identities in the classroom.

Fennema et al. (1990) presented findings from a statistical study involving 38 first grade teachers (all female) across 24 schools regarding their perceptions of mathematics success for females and males in their classrooms. The three major findings from this study included mathematics teachers' (i) attributions of males' success to innate mathematics ability, (ii) characterization of mathematics success as engagement in *autonomous learning behaviors* --- namely, being "more competitive, more logical, more adventurous, volunteer[ing] answers more often to mathematics problems, [and]... more independent in mathematics," (p. 55) and (iii) inaccurate ratings of males' actual mathematics achievement.

With these findings, Fennema et al. (1990) raised concerns about how differential teacher beliefs on females and males' mathematics ability may lead to inequitable

opportunities for success in the classroom. Males in the teachers' first grade classrooms were disproportionately rated as being mathematically successful with their strong performance attributed to autonomous learning behaviors such as natural confidence and independence. Females' mathematics success, on the other hand, was more accurately rated yet perceived as being based more on individual effort and less on natural ability. These differential and inaccurate perceptions of mathematics success, as a result, brought Fennema et al. (1990) to question how teacher beliefs may produce inequitable patterns of student acknowledgment that lead to the well-documented sex differences in the achievement literature.

Fennema et al.'s (1990) findings, moreover, served as a starting point for the scholarly consideration of how teacher beliefs and school structures play a role in the gendering and, I argue, underlying racializing of sociomathematical norms associated with mathematics success. The value that the first grade teachers in Fennema et al.'s (1990) sample placed on autonomous learning behaviors, for example, potentially marginalized students who were less competitive, risk-taking, vocal, independent, etc. It should be noted how these autonomous learning behaviors described in Fennema et al.'s (1990) study directly aligned with cultural values of competition and independence among white, middle-class men in the United States (Moore, 2008). While this is left implicit in the study, Fennema et al. (1990) provide an opportunity to note ways in which whiteness can intersect with issues of gender. Students in the study, as a result, had to unfairly subscribe to the valued classroom norms with inherent cultural and gender biases leading to inequitable opportunities of being perceived as mathematically competent.

Shifting from a classroom- to school-level analysis, Boaler (2002a) shared insights from a three-year ethnographic study that compared advanced females and males' mathematics classroom experiences in two non-selective, comprehensive schools in England (analogous to public high schools in the United States) -- Amber Hill and Phoenix Park. Both schools primarily consisted of white, working-class students aged between 13 and 16 but differed in terms of their social class settings and approaches to mathematics instruction. Amber Hill was situated in an affluent area with greater job accessibility while Phoenix Park was in a more working-class neighborhood with students' families living in public housing. While Amber Hill used traditional mathematics teaching methods that mainly focused on procedures, Phoenix Park structured its mathematics instruction with more reform, discussion-based interventions including various projects. Females experienced less academic struggles and enjoyed mathematics more in Phoenix Park while males were observed to have similarly positive mathematics experiences in Amber Hill. Analogous to Fennema et al.'s (1998) observed sex differences in problem solving approaches, Boaler (1997) attributed differences in participants' mathematics experiences to the alignment between the schools' pedagogical approaches and students' sex-based mathematics learning styles – namely, females' “quests for understanding” to make sense of the taught mathematics and males' “school mathematics games” focused on efficiency and algorithmic approaches to completing mathematics tasks.

Boaler (2002a), furthermore, used interview and observation data to detail how the females and males adopted strategic moves in negotiating their mathematics learning practices and the two schools' mathematics curricular structures. Phoenix Park males, in



particular, were described to “play the game” (Boaler, 1997, p. 11) by overlooking their minimal understandings of school mathematics and focusing on quickly getting correct answers to remain mathematically successful. On the other hand, Amber Hill females dwelled on their inability to build conceptual meanings of the mathematics, lagged behind males academically, and were described as feeling powerless in changing their school’s mathematics teaching approaches. Boaler’s (2002a) observed disparities between the female and male cohorts’ adoption of effective coping strategies pointed to the importance of detailing individual students’ discursive negotiations of mathematics success with regard to their gender identities and mathematics learning contexts.

Moreover, it is worthwhile to consider how the Amber Hill and Phoenix Park students’ working class backgrounds intersected with their gendered engagement with mathematics. For example, in a follow-up study eight years later, Boaler (2015) noted how former Phoenix Park students reflected on school mathematics being directly applicable to their work situations after graduation. Females’ focus on conceptual understanding of mathematics, thus, conflicts with Phoenix Park’s vocational vision of success which in turn explains their male peers’ success by “playing the game” of school mathematics. Though such interrelationships of gender and class were implicit in Boaler’s (2002a) analysis, Boaler (2002b) looks back on her findings to later raise the following question for future research on intersections of gender and other social identities with mathematics, “How do identities of race, class, and gender intersect with those of mathematics?” (p. 47).

Although these two sex-based participation studies adopted conceptualizations of gender as a female-male binary, they still allude to how mathematics can be a gendered

experience through students' negotiations of mathematics success with contextual factors such as teacher beliefs, curricula, and classroom instruction largely unexplored in the achievement literature. Sex-based participation studies, thus, shifted the object of analysis in gender research away from being solely on individuals' mathematics ability and toward gendered "co-productions" (Boaler, 2002c) of experience between students and their mathematics learning environments. At the same time, both sex-based participation studies reviewed here illustrated how mathematics is an academic space where students constantly negotiated their mathematics learning practices as well as their respective positions along a gendered hierarchy of mathematics success. Moreover, as noted with respect to Fennema (2000), participation studies began to raise the possibility of integrating analyses of gender with issues of class and race, though the studies discussed here do not take this up explicitly.

**Gender-based participation: Doing mathematics = doing gender = doing masculinity.** Gender-based participation scholarship draws on queer theory (Butler, 1990, 2004) in its theorization of gender as a social construct performed differently across contexts and individuals. This conceptualization redefined "gender difference" from achievement and sex-based participation scholarship to be dynamic, relational, and situational (Mendick, 2006). More specifically, gender-based participation studies explored how mathematics was a site of masculinization through both narrative and situated accounts of students' experiences with the subject (Barnes, 2000; Mendick, 2006). As Esmonde (2011) wrote, "Mathematics classrooms can be the site of gender struggles between boys and girls, certainly, but also between *various forms of masculinity*" (p. 30, emphasis added). Thus, while observations in gender-based

participation studies allowed researchers to examine how gender was relationally produced through mathematics classroom interactions, interviews provided personal insights on the extent to which gender played a role in how students made meaning of their mathematics experiences.

The gender-based participation perspective in mathematics education adopted a post-structuralist lens of analysis to understand how mathematics success is discursively and relationally produced as a source of power (Damarin, 2000; Esmonde & Langer-Osuna, 2013; Mendick, 2005, 2006). Damarin (2000) wrote, “The discourse of mathematics as a key to power has been central (if often unstated) to think about gender and mathematics” (p. 78). By expanding on sex-based participation scholarship, the post-structuralist analysis of gender-based participation studies explored individual students’ strategic moves and narratives of experience to better understand how they positioned themselves along the gendered hierarchy of mathematics success. With mathematics deemed a power-laden and masculinized academic domain, gender-based participation studies highlighted how both girls and boys experience the “double-edgeness of power” (Mendick, 2006, p. 20) – namely, Foucault’s (1990) notion of “where there is power, there is resistance” (p. 95) -- resulting in different forms of gendered negotiation of being mathematically competent. This review considers Barnes (2000) and Mendick’s (2006) research studies to explore the gender-based participation perspective. While Barnes (2000) used ethnographic evidence to detail the discursive construction of a gendered hierarchy of mathematics ability in a calculus classroom, Mendick’s (2006) thematic analyses of interviews examined the discursive strategies that young college students

adopted in making gendered meanings of their identities and decisions to pursue mathematics.

Barnes (2000) conducted an ethnographic study in an advanced high school calculus classroom in Australia to explore how student subgroups engaged with varying discourses of masculinity during collaborative learning opportunities. To accomplish this, Barnes (2000) looked across multiple data sources including videotaped lessons, individual student interviews, focus groups, field notes, and work samples to examine the “interaction of student gender, the social construction of mathematical competence, and ways in which mathematics is valued” (p. 145). The major finding from the study was the discursive production of two subgroups of boys in the calculus classroom – namely, Mates and Technophiles – whose classroom learning behaviors greatly differed. Barnes (2000) described how the Mates and Technophiles constructed patterned forms of masculinity for being mathematically successful by tapping into social and intellectual forms of capital respectively. While the Mates used their recognized athleticism and extracurricular involvement to approach mathematics with a sense of coolness, the Technophiles embodied a “rational form of masculinity” (p. 163) maintained through exclusive problem-solving behaviors and their calculus teacher’s academic praise. In contrast to Boaler’s (2002a) sex-based separation of mathematics learning approaches across two schools, Barnes (2000) employed a more nuanced lens of analysis to highlight the gendered variation of doing mathematics among boys in a single classroom.

With post-structuralist considerations for gendered power dynamics, Barnes (2000) identified the Mates as being “closest to the stereotype of hegemonic masculinity” (p. 145) in the calculus classroom. In other words, the Mates expressed the more

dominant form of masculinity based on societal standards for men and their gender roles compared to the Technophiles. The power in the Mates' masculinized scripts of mathematics engagement is observed in the marginalization experienced by the Technophiles and other calculus classmates. Girls in the classroom, for example, were treated as the Mates' mathematics "helpers or assistants" which they regularly tolerated and even excused. The Technophiles' subordinate masculinity as the stereotypical "nerds" of the classroom brought them to be often ignored by their peers including the Mates except when acknowledged by the calculus teacher. In alignment with the Foucauldian idea of "where there is power, there is resistance," the classroom's social outcasts, the Technophiles, used their attributed intellectual superiority as a gendered form of academic resistance to subsequently reject their less mathematically-competent classmates (including girls despite being similarly apt and engaged) and any of their problem-solving contributions.

These masculinizing discourses of doing mathematics, therefore, structured a complex, gendered hierarchy of mathematics ability that differentially positioned both individual girls and boys in the calculus classroom. In alignment with Boaler's (2002a) analysis of boys' negotiations of their mathematics success with institutional structures of mathematics teaching, it is important to consider how the Mates, Technophiles, and other calculus students negotiated the calculus classroom's gendered discourses of successful mathematics performance. Barnes (2000) discussed how students often found themselves at the juncture of these commonly conflicting discourses. One of the boys, Mike, for example, was described as "manag[ing] a delicate balancing act" (p. 164) in protecting his Mate classroom identity while still meeting the calculus teacher's expectations for

mathematics success. This example illustrates how mathematics classrooms serve as “spaces of authoring” (Boaler & Greeno, 2000) where individual students negotiate mathematics success with their identities. Barnes (2000) wrote, “As students interact... while struggling to make meaning of the mathematical ideas they are encountering, they are at the same time developing ideas about how to learn mathematics, and constructing views of themselves as learners or doers of mathematics” (p. 147).

In efforts to make meaning of men’s disproportionate representation in the mathematics field, Mendick (2006) presented results from a multi-site British school ethnography that explored young college students’ choices in pursuing mathematics coursework through 43 individual student interviews and three-week classroom observations. The three colleges considered in Mendick’s (2006) study varied across student demographics including an inner-city comprehensive with a working-class population (Grafton), a selective school with middle-class students (Westerburg), and a school with foreign, non-traditional college students (Sunnydale). Using thematic narrative analysis of the interview data, Mendick (2006) highlighted how men were more likely to opt into mathematics studies for career development and identify as mathematicians compared to girls and women across the college sites. Another noteworthy finding was how only college women viewed studying mathematics as a way of “proving something to themselves.” Mendick (2006) posited that these different interpretations of students’ mathematics pursuits are explained by the idea that “in choosing maths<sup>6</sup>, they [students] are simultaneously doing gender” (p. 169).

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<sup>6</sup> The term *maths* from the British English language used in Mendick (2006) is interchangeable with *math* or *mathematics* from North American English. For

Similar to Barnes' (2000) gendered classroom discourse analysis, Mendick (2006) examined the masculinizing influences of doing mathematics by interviewing individual students about past experiences and perceptions of mathematics with a focus on gendered meaning-making patterns. With the study's relational view of gender that explores femininities and masculinities among the college women and men, these interviews provided Mendick (2006) with a glimpse into individual students' "gender identity projects" in mathematics including those of women, a population minimally discussed in Barnes' (2000) ethnographic work. Interviews, in other words, served as the college students' spaces of authoring where they engaged in "identity work" (Mendick, 2005) by negotiating various discourses on gender and mathematics. Mendick (2005) discussed how "gendered discourses of rationality," in particular, brought mathematics ability to be socially acknowledged as a masculine attribute that, in turn, caused women to struggle in identifying themselves as being "good at maths."

As a result, both college women and men described their respective positions within this gendered binary of "good at maths"/"not good at maths" resulting in femininity and masculinity projects of mathematics identity. While some college men (Peter, Phil, and Saldon) shared beliefs about the natural separation of mathematicians like themselves and non-mathematicians analogous to the Technophiles' exclusionary mathematics behaviors, other college men (James, Michael, and Simon) adopted views of pursuing mathematics as "hard work" for future professional advancement as opposed to the "effortless achievement" described by their mathematician-identifying peers. The consistency, the review will continue to use the term *mathematics* unless directly quoting Mendick (2006).

second group of college men, therefore, engaged in a “new mode of school student masculinity” (Mendick, 2006, p. 73) comparable to the Mates’ views of mathematics as a career credential, but the limited use of observations in Mendick’s (2006) analysis does not provide situated insights into how this masculinized discourse manifested itself in the college mathematics classroom. It is noteworthy how the college men’s reflections either asserted being “good at maths” or described their efforts for being mathematically successful with no claims of simply being “not good at maths” as raised by some of Mendick’s (2006) college women participants (Ling and Rachel).

Mendick (2006), at the same time, also discussed how mathematics is socially constructed as a source of knowledge and truth such that pursuits of and success in mathematics are deemed powerful. This power of mathematics, however, is gendered through its societal recognition as a masculine domain resulting in inequitable opportunities for women compared to men. As a result, college men and women encountered a gendered network of power relations in pursuing mathematics much like the gendered hierarchy of mathematics ability structured in Barnes’ (2000) calculus classroom.

By choosing mathematics, individual college men and women encountered power’s double-edgeness and thus had to negotiate their respective gender identities with masculinized mathematics discourses resulting in both empowerment and tensions throughout their identity projects (Mendick, 2006). Several college men (James, Michael, and Simon) reflected on pursuing mathematics as a challenging academic subject in efforts to “prove something to others.” For example, Michael perceived mathematics success as a way to validate his academic ability and respond to racist



discourses on African-Caribbean men like himself. Michael, however, was the only instance that the intersection of ethnicity and gender was noted in Mendick's (2006) analysis. Another instance of this double-edgeness of power was observed among Mendick's (2006) men participants successful in college mathematics who discursively resisted losing their established sense of masculinity vis-à-vis mathematics through discussions that separated themselves from "non-mathematicians" and asserted being hard working rather than naturally talented. Thus, "hard work" for future professional advancement characterized hegemonic masculinity in this context whereas the "socially incompetent mathematicians" (Mendick, 2003) and "non-mathematicians" were the subordinate forms of masculinity. This is analogous to the maintenance of different masculinities in Barnes' (2000) calculus classroom evidenced in the separations between the Mates and Technophiles as well as the Technophiles and the remainder of the class. As a result, students like Graham in Mendick's (2000) study at the intersection of these conflicting gendered discourses acknowledged how he must protect his "authentic intelligence" as a mathematician while still privately valuing the notion of "hard work" in mathematics. Graham, much like Mike in Barnes' (2000) ethnography, was engaged in a discursive balancing act with two differentially masculinized views of doing mathematics to maintain his hard-working mathematician identity.

At the same time, Mendick's (2006) conceptualization of gender coupled with her post-structuralist analysis allowed for the consideration of gender transgressions (Davies, 1989) in college women's discursive negotiations of their gender identities with the masculinized, powerful notion of being "good at maths." This is a conceptual advance on Boaler (2002a) and Barnes' (2000) participation work that broadens analytical

opportunities for not only how men and women do mathematics similarly, but also how gendered binaries of success in mathematics are challenged in individual men and women's construction of mathematics identities. For many college women in Mendick's (2006) study, choosing mathematics was a way to "prove something to themselves" which led to varying forms of gendered resistance and tensions specific to their feminine identities in a masculinized field. Successful women in college mathematics, more specifically, shared strategic moves in "using maths to do masculinity" (p. 82) while viewing masculinity as inaccessible to them as women. While Toni shared her good grades in mathematics for intellectual acknowledgment and career development, Lucy often hid her mathematics ability and selectively shared her skills with others. In the meantime, Mendick (2006) described some other successful college women as attempting to be "the ideal neoliberal subject" (Mendick, 2006, p. 95) by discounting their female and feminine identities as being associated with mathematics ability. Thus, Mendick's (2006) more complex and localized analysis of men and women's narratives on pursuing college mathematics effectively considered the individual experiences of empowerment and marginalization often lost in the homogenizing binary groupings (e.g., male/female, boy/girl) of preceding gender scholarship.

***Research implications from participation perspective.*** Overall, participation scholarship advanced research approaches to both conceptually understand and methodologically study gender issues in mathematics education. Sex-based participation work provided the field with better understandings of how contextual influences such as teacher beliefs, curricular structures, and instruction shaped schools and classroom as gendered spaces for learning mathematics. This scholarship, thus, unpacked the

achievement perspective's statistical findings on individual mathematics ability by considering the gendered "co-productions" (Boaler, 2002c) between students and their mathematics learning situations. Adopting a reform conceptualization of gender as socially constructed (Butler, 1990, 2004), gender-based participation studies expanded on such explorations of gendered co-productions through interviews and observations to detail how students negotiated their identities with gendered discourses of mathematics success. Such analyses of mathematics as a site of masculinization allowed for considerations of variation within groups of women and groups of men in their discursive positioning along a gendered hierarchy of mathematics ability. This was a conceptual and methodological advance from the sex-based participation perspective's female-male group analyses by considering individuals' differentially gendered ways of doing and making meaning of mathematics.

Despite such progress, limited consideration was given in achievement and participation studies to how other social identities including race and class intersected with students' gendered experiences and identities in mathematics. Fennema et al. (1990) discussed how school structures and teachers' personal biases may serve as systematic influences on student achievement, but no information about the sampled teachers or students' racial and class backgrounds was considered in their study's analysis. Similarly, findings from Boaler's (2002a) ethnographic study explored gendered patterns of mathematics engagement among white, working-class students in two England schools located in socioeconomically different areas. Boaler (2002a) noted sex-based differences including female students' "quests for understanding" and male students' "school mathematics games." However, what remains implicit in Boaler's (2002a) analysis is

how such sex-based differences are manifestations of how social class intersects with gender to shape students' strategies for success in mathematics classrooms with either an academic or vocational focus.

Meanwhile, Mendick (2006) adopted a relational model of gender that claimed to “explore how inequalities of class and race/ethnicity interact with gender” (p. 11) when college students pursue mathematics. However, ethnicity is only explicitly discussed once when considering one African-Caribbean student Michael's reflections on how his mathematics success served as a response to others' racial views of poor mathematics ability among students of color. An explicit intersectional analysis of gender and race, as a result, is missing from this and other narrative analyses presented in Mendick's (2006) work. Although Mendick (2006) acknowledged that these other social dimensions were not the primary focus of her analysis, they are important considerations for future research that examines students' gendered mathematics experiences as gender is both raced and classed. Thus, there remains much analytical space in the gender research literature to critically examine how these intersections between gender and other social dimensions further explain students' engagement and identities in mathematics.

Whiteness, furthermore, is excluded across the sex-based and gender-based participation studies' analyses of racialized influences in mathematics learning practices and identities. Intersectional analyses across the participation studies would have allowed for the exploration of racialized and gendered influences on the mathematics experiences of white girls and boys (Sue, 2004). Without such a conceptualization of race in the participation scholarship, however, white students' mathematics experiences were not deemed racialized. An example of such theoretical considerations of white

students as raceless was evidenced in Boaler's (2002a) assertion that white females and males constructed their mathematics identities as "(un)productive gender responses" to classroom environments similar to the (un)productive racialized responses among students with different cultural backgrounds. This theoretical drawback across the participation studies, as a result, rendered whiteness and privilege as both invisible and racially neutral in their respective analyses.

It should also be noted that much of the participation scholarship reviewed here was conducted outside of the United States. While Barnes' (2000) calculus classroom ethnography took place in Australia, Boaler (2002a) and Mendick's (2006) studies on mathematics student experiences were conducted across various school sites in England. Social norms of race and gender vary across international contexts as noted in Hanna's (1988) international study; thus, insights from these participation studies may not directly translate across different geographic locations including the United States. Thus, much remains to be explored about individual students' gendered mathematics experiences in the Americas and how this compares with extant participation research findings from other nations. In addition, many of the studies do not theorize how the social norms of the local context related to the results. Understanding the impact of geographic and social context is a space for future gender research in mathematics education.

#### **2.4 A Call for Intersectional Analyses of Gender**

Both the achievement and participation perspectives on gender research in mathematics education made significant conceptual and methodological advances to inform future scholarship in the field. Achievement scholarship's findings challenged the long-standing assumption of male superiority in mathematics which in turn shifted the

analytical focus toward contextual influences and learning processes to make sense of sex-based disparities in mathematics achievement. This analytical shift brought forth the adoption of interview and observation methodologies in late achievement and sex-based participation studies to qualitatively detail gendered patterns of engaging with mathematics in school and classroom contexts. Gender was conceptualized interchangeably with sex under the achievement and sex-based participation perspectives; thus, analyses were limited to female-male group comparisons that left implicit any within-group variation. In efforts to explore and learn from these individual differences, more recent scholarship under the gender-based participation perspective drew on queer theory to conceptualize gender as dynamically and relationally produced by individuals across different contexts. This informed the use of post-structural analyses of individual participants' strategies in navigating mathematics as a site of masculinization and negotiating their identities with gendered discourses of mathematics success.

Despite this development in scholars' conceptualization and empirical study of gender in mathematics education, the intersections of gender with other dimensions of students' identities including race and class remain implicit or unexplored in these analyses. Damarin & Erchick (2010) wrote, "If mathematics education research is to promote equity for girls and women within multiple racial and ethnic groups, similar attention to the intersection of clearly defined constructs, including gender, is required" (p. 312). Either race or gender has traditionally been adopted as the lens of analysis in the equity literature to understand social forms of marginalization among diverse mathematics learners (Berry, 2008; Boaler, 2002a; Damarin, 2000; Fennema et al., 1998; Martin, 2000; Mendick, 2006; Moschkovich, 2013; Stinson, 2008; Terry, 2010).

However, as noted in the review of the achievement and participation literature, research that focuses on a single construct of identity potentially leaves implicit the analysis of variation across individuals' negotiations of racialized, gendered, and other social norms and discourses of mathematics success. Scholars are, therefore, calling for more complex understandings of students' gendered mathematics experiences particularly at the intersections with their racial identities (Campbell, 1989; Damarin & Erchick, 2010; Esmonde, 2011; Esmonde et al., 2009; Lim, 2008; Martin 2009; Reyes & Stanic, 1988).

Although intersectional analyses of gender offer a promising way to establish more complex understandings of students' mathematics ability and experiences, this has yet be done effectively from both conceptual and methodological standpoints in much of the gender research literature. Esmonde (2011) identified one of these common pitfalls in past researchers' use of intersectional analyses as making faulty subgroup comparisons such as looking across females and males from different racial backgrounds. Participant sampling appropriately informed by intersectionality is observed across research studies using critical race theory (CRT) to examine the narratives of mathematics experience among student populations traditionally marginalized in mathematics (e.g., African American males). Although intersectionality is one of the tenets of the CRT framework in educational research to examine how racism intersects with other forms of oppression (e.g., sexism, classism), CRT studies in mathematics education offer analyses that primarily focus on race and sex separately with considerations of their intersections left implicit.

CRT studies, in addition, adopt conceptualizations of gender as female-male binary that limit considerations of mathematics as a racially masculinized space resulting

in intersectional forms of oppression for participants including African Americans and Latin@s. Terry (2010), for example, acknowledged the need for such intersectional analyses in future CRT scholarship on African Americans in mathematics framed in a “broader theoretical discussion of constructed academic identities vis-à-vis Black masculinity” (p. 96). However, a common misinterpretation in exploring these intersections is researchers’ consideration of social oppressions as additive or compounded instead of related and interconnected (e.g., multiply oppressed, double jeopardy). In efforts to depart from these problematic analyses and interpretations in gender research, I argue that future scholars should draw upon CRT and, more specifically, intersectionality (Crenshaw, 1991) to examine mathematics achievement and experiences as a function of the interplay between individuals’ gender and other identities (e.g., race, class, language).

Despite these challenges associated with intersectional studies of gender, we can learn from and build upon the achievement and participation perspectives in gender scholarship by complementing them with intersectional analyses to detail within-group variation in mathematics experiences (Lubienski, 2001; McGraw, Lubienski, & Strutchens, 2006; Moore & Smith, 1987; Stanic & Hart, 1995; Tate, 1997). This section first explores the works of Lubienski (2001) and McGraw et al. (2006) as key research studies that examine intersections of sex, class, and race to problematize well-documented achievement gaps in the mathematics education literature. Stanic and Hart’s (1995) ethnography is then discussed as another research study employing an intersectional analysis of race-sex student subgroups’ mathematics classroom experiences and their differential impact on mathematics achievement and affect. While these three



studies advance the gender research agenda in terms of detailing patterns of mathematics achievement and experience by intersectional subgroups, sex as opposed to gender is the analytical focus and thus does not allow for nuanced considerations of how other social identities (e.g., race, class) interact with gender in making sense of these intersectional subgroup findings. The three studies presented here, therefore, are used to highlight what can be drawn from the reviewed perspectives of gender research, including the conceptualization and empirical study of gender as a social construct, to inform future intersectional work in mathematics education.

Lubienski (2001) applied a reform framework for statistical analysis that explored intersections of race, class, and “gender” to offer more complex understandings of well-documented mathematics achievement gaps. Although Lubienski (2001) conceptualized gender to be synonymous with the two biological categories of sex, her explorations of within-group variation in mathematics achievement on the National Assessment of Educational Progress (NAEP) shed light on contextual factors such as classroom instruction, student beliefs, and teacher perceptions that may have impacted students’ varying mathematics experiences. Lubienski’s (2001) simultaneous consideration of race, class, and sex in high school seniors’ NAEP performance, for instance, highlighted how Black males from low socioeconomic status (SES) backgrounds experienced the smallest average increase in mathematics achievement (namely, 1 point) of all considered race-class-sex groups including Black females (14 points) and upper-SES Black males (17 points). This finding challenged males’ mathematical superiority framing the achievement perspective and pointed to the promise of intersectional analyses in detailing the social complexities on gendered mathematics achievement inequities.

Similarly, McGraw et al. (2006) examined how “gender gaps” in NAEP mathematics achievement data varied across race/ethnicity and socioeconomic status (SES) despite their sex-based conceptualization of gender. I argue that these scholars were, therefore, examining sex-related NAEP achievement gaps. In addition to the sex-based variability across mathematics content areas and performance percentiles, the scholars noted variability in statistically significant gap differences when intersected with race. This included higher mathematics achievement for white males, Hispanic males, and Black females in fourth and eighth grades. Although effect sizes for these sex gap differences were relatively small, these intersectional findings across race-sex subgroups captured how considerations of social complexities in quantitative analyses of mathematics achievement lead to more nuanced insights that problematize broad claims of race-based and sex-based gaps in mathematics. McGraw et al. (2006) called for further intersectional analyses in future research that complicate achievement differences in mathematics, “[T]his work needs to attend not only to gender differences but to interactions among race/ethnicity, gender, SES, and other variables if we are to further our understanding of the complex relationship among mathematics attitudes, achievement, and student/teacher practices within and across school contexts” (p. 147).

In order to take up McGraw et al.’s (2006) call for intersectional research, scholars must conceptualize and study gender as a social construct in order to examine its dynamic interplay with other social identities like race and class. This was lacking in Lubienksi (2001) and McGraw et al.’s (2006) studies with a focus on sex as a statistical variable even though their analyses represented an advance from the achievement literature by exploring within-group achievement variation at intersections of sex, race,

and class. Much like late achievement scholarship, Lubienski (2001) and McGraw et al. (2006) point to the importance of contextual influences (e.g., teacher perceptions, curriculum, mathematics instruction) at school and classroom levels to make meaning of achievement differences across intersectional subgroups. These contextual considerations, in addition, offer insight into students' different co-productions of mathematics experiences at intersections of gender, race, and class – an advance from participation studies that left racialized and classed variations of gendered experiences implicit in their analyses.

Considering such contextual influences on mathematics achievement, Stanic and Hart (1995) presented findings from a 45-day ethnographic study in a diverse, seventh-grade mathematics classroom that examined race-sex student *archetypes* -- the interrelationships between students' achievement (i.e. class grades, standardized tests) and affect (i.e. confidence, enjoyment, persistence, perceived utility) in mathematics. Through observations of teacher-student classroom interactions as well as semi-structured teacher and student interviews, Stanic and Hart (1995) addressed achievement studies' need for examining environments and student reflections on mathematics learning to identify influences on racialized and gendered trends in mathematics achievement and affect. One instance in which this methodological approach proved beneficial was in making meaning of the seventh grade females' higher ratings of perceived utility of and persistence in mathematics than males. Although such results would be expected for females based on earlier achievement study findings, the observation and interview data proved these statistics to be problematic as students were

offered minimal opportunities for persistence and demonstrated shallow views of mathematics utility.

Stanic and Hart (1995), furthermore, adopted an intersectional approach to detailing connections between mathematics achievement and affect for four race-sex student groups (African American females and males as well as white females and males). This examined within-group variation in the two sex groups provided the researchers with statistical findings that challenged earlier achievement studies' claims of all adolescent females demonstrating weaker mathematics performance and interest than males. African American females, for instance, consistently scored higher than males on scales of achievement and perceived utility in addition to being the most mathematically confident of all race-sex groups. Stanic and Hart (1995) described this intersectional approach as the "most productive level of group analysis" (p. 275) that confirms the methodological affordance of examining individual students' mathematics experiences instead of homogenizing group differences in future gender research.

Looking across these three studies' intersectional approaches, there remains a need for research in mathematics education that conceptualizes and examines gender as a social construct to make meaning of mathematics achievement and participation at different intersections of identity. Lubienski (2001) and McGraw et al. (2006) highlight the importance of exploring within-group differences to avoid reverting back to the oversimplified discourse of male superiority in mathematics and perpetuating the "gap-gazing fetish" (Gutiérrez, 2008) in mathematics education. In order to unpack these achievement differences across intersectional subgroups, we must complement these statistical analyses with qualitative methodologies (e.g., interviews, observations) that

offer insight into contextual factors that differentially shape students' ability and experiences with mathematics as explored in Stanic and Hart's (1995) classroom ethnography.

Intersectionality in educational research, however, goes beyond sampling at various intersections of gender, race, and class in a data set or classroom; it is an analytical tool to examine how individuals at these intersections negotiate their multiple identities including gender with mathematics success and make meaning of their experiences. Thus, I argue that in order to better understand gendered patterns of achievement and participation well documented in mathematics education, future scholars must build upon these three studies' intersectional subgroup considerations and adopt a conceptualization of gender as a social construct to examine how mathematics performance and experiences are shaped differently across different intersections of identity.

## **2.5 Discussion and Implications**

This literature review presented two perspectives of studying gender in mathematics education research – namely, achievement and participation -- premised on scholars' conceptualizations of gender and methodological approaches to their empirical work. Achievement scholars used statistical findings of mathematics ability to challenge the long-standing assumption of male superiority in mathematics as well as call for considerations of contextual factors to further explain female-male achievement disparities. In response, participation scholars adopted qualitative methodologies including interviews and observations to obtain contextual understandings of sex-based or gender-based variation across students' approaches to mathematics. Significant

progress has been evidenced in recent scholars' conceptual distinctions of gender and sex in their analysis unlike the synonymous and interchangeable use in the earlier achievement and sex-based participation perspectives. In addition, theorizations of gender as a dynamic and contextual identity dimension in the gender-based participation literature (Barnes, 2000; Mendick, 2006) have offered nuanced understandings of mathematics as a gendered and, more specifically, masculinized domain resulting in varying educational experiences for both men and women. A limited number of empirical studies adopt this conceptualization of gender as a social construct; thus, there remains much analytical space for such understandings of gender and their impact on students' mathematics experiences.

I argue that complementing such situated analyses of gender with intersectionality from CRT allows for more complex insights on women and men's experiences at the intersections of gender and other social identities including race. Although intersectionality should inform the research methodologies and analyses as a CRT tenet, this has yet to be done effectively in much of the CRT studies even in mathematics education examining the narratives of marginalized student populations including African American men and Latin@s. Much of the CRT literature largely focuses on the racialized dimensions of students' experiences with traditional sex-based conceptualizations of gender. CRT scholars acknowledge how the adoption of more nuanced constructions of race and gender would allow for deeper understandings of marginalized students' identity negotiations across mathematics spaces (Stinson, 2008; Terry, 2010). These limitations in detailing the interplay of race and gender in students' responses to oppression in mathematics provide future gender researchers with a template

in examining the intersectional variation in students' gender identity projects in mathematics (e.g., "Black masculinity" [Terry, 2010]). Such intersectional explorations of gender as racialized discursive responses varying across contexts and individuals allow future researchers to acquire situated understandings when gender, race, and other identities become more salient in students' mathematics experiences.

Analogously, race was virtually absent in achievement and participation scholars' sex- and gender-based examinations of academic performance and meaning making in mathematics. Whiteness, like gender, is a racial construct that intersects with individuals' gender and other identities and in turn shapes the mathematics experiences of white men and women, including those in the achievement and participation studies (Battey, 2013a; Sue, 2004). However, such intersectional considerations of mathematics achievement and participation were left implicit in the analyses. The invisibility of whiteness in early gender studies and gender as a social construct in CRT work begins to be addressed by mathematics education scholars' adoption of intersectional analyses of race-sex subgroups' mathematics success from qualitative and quantitative standpoints (Lubienski, 2001; McGraw et al., 2006; Stanic & Hart, 1995). Despite their traditional female-male conceptualization of gender, these scholars' analyses advance the gender research agenda by highlighting within-group variations in mathematics achievement and in turn problematize broad racial and gendered discourses of mathematically (dis)advantaged groups.

As a call for future research, it is critical that scholars examine the influences of different contexts on students' mathematics experiences at the intersections of their gender, race, and other identities. While the majority of achievement and sex-based

participation studies were conducted in the United States, insights from the gender-based participation lens came from research completed in Australian and British school sites. Much remains to be explored in the United States and other national contexts on the extent to which the masculinization of mathematics differentially impacts students' performance and experiences. At the same time, gender scholars in mathematics education must closely consider the different levels of influence that simultaneously shape students' mathematics identities including institutional (e.g., school policies, mathematics curriculum), interpersonal (e.g., peers, teachers, family), and ideological (e.g., stereotypes, cultural norms) to obtain holistic representations of gender across these different sites of identity negotiation with mathematics success (Leyva, under review). Coupling achievement data with situated insights on mathematics participation (e.g., interviews, observations) across intersectional subgroups effectively raises individual student voices and in turn deconstructs the limiting narratives of mathematics ability ascribed to entire social groups.



### **Chapter 3: From “Smart for a Girl” to “Acting White”:**

#### **An Intersectional Analysis of First-Year African American and Latin@ College Women’s Counter-Stories of Mathematics as a Gendered and Racialized Experience**

##### **Abstract**

In this chapter, the author details the intersectionality of mathematics experiences among four first-year African American and Latin@ college women pursuing STEM majors at a large, predominantly white university. This study used critical race theory and post-structural theory to explore the women’s counter-stories in making meaning of their experiences in relation to gendered and racial discourses of mathematics ability. A cross-case analysis examines their strategies in navigating these discourses such as selectively sharing accomplishments, positioning themselves as exceptions, and building peer and family support networks. While the African American women discussed the emotional labor of managing the intersectional ambiguity of microaggressions, the Latin@ women challenged the discourse of becoming young mothers and wives instead of pursuing higher education. Implications are raised for P-16 mathematics education and STEM support initiatives to broaden opportunities for African Americans, Latin@s, and other marginalized groups’ construction of positive mathematics identities at intersections of gender and race.

**Keywords:** critical race theory, discourse, gender, intersectionality, mathematics identity, race

### 3.1 Introduction

Extant research has often adopted either gender or race for its lens of analysis in understanding experiences of marginalization among women and students of color in mathematics (Berry, 2008; Boaler, 2002a; Damarin, 2000; Fennema et al., 1998; Martin, 2000; Mendick, 2006; Stinson, 2008; Terry, 2011). However, research that focuses on a single dimension of identity risks homogenizing group experiences and overlooking within-group differences for negotiating gendered and racialized discourses<sup>7</sup> in mathematics.

At the undergraduate level, for example, researchers have largely focused on examining negative influences among African Americans and Latin@s with limited analysis of influences associated with their success in STEM. Future scholarship, therefore, is needed that qualitatively unpacks African American and Latin@ students' strategies of resilience and persistence in postsecondary STEM education particularly at intersections of gender, race, and other dimensions of their social identities (Chapa & De La Rosa, 2006; Cole & Espinoza, 2008; Harper, 2009).

To do this, scholars argue for the conceptual and empirical affordances of intersectional analyses to obtain more nuanced understandings of gendered and racialized influences on underrepresented college students' STEM retention and success (Espinoza, 2011; Solórzano et al., 2000; Zambrana & Macdonald, 2009). Mathematics education

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<sup>7</sup> I draw on Stinson's (2008) definition of *discourses* as the "language and institutions as well as complex signs and practices that order and sustain sociocultural and sociohistorical constructed forms of social existence" (p. 977) in the context of this research study.

scholars, for example, call for such intersectional considerations in order to closely examine marginalized students' strategies in negotiating their mathematics success with existing gendered and racial discourses of mathematics ability (Esmonde et al., 2009; Lim, 2008; Martin 2009; Oppland-Cordell, 2014). Intersectional analyses, furthermore, nuance our understandings of undergraduate mathematics education as a gendered and racialized space for African Americans (McGee & Martin, 2011), Latin@s (Oppland-Cordell, 2014), and women (Mendick, 2006) as well as inform ways to better support and broaden opportunities for these marginalized populations in mathematics.

Intersectionality, one of the tenets of critical race theory (CRT) in educational research, considers the mutual constitution of oppression at intersections of race, class, gender, and other social identities (Solórzano, 1998). Although CRT research in mathematics education has drawn on intersectionality for the sampling of participants (e.g., African American boys), much of its analysis adopts static, sex-based conceptualizations of gender (namely, a male/female binary) with limited consideration of how participants' mathematics experiences are shaped by the dynamic interplay of their gender and race (Leyva, accepted). With a conceptualization of gender as a social construct discursively produced in different ways across contexts and individuals (Butler, 1990), intersectional analysis allows for explorations of how the racialized masculinization of mathematics structures inequitable opportunities for success among African American and Latin@ women – two marginalized populations largely absent in CRT mathematics education research.

This research study presents four case studies of first-year African American and Latin@ college women pursuing math-intensive majors at a large, predominantly white

institution in the northeastern United States. Using post-structural theory as well as intersectionality (Crenshaw, 1991) from critical race theory, I closely examine these historically marginalized college women of color's counter-stories in mathematics with a focus on their negotiations of mathematics success with their gendered and racial discourses of mathematics ability (Solórzano & Yosso, 2002). This analysis addresses the following questions that explore mathematics as a gendered and racialized experience for these first-year college women of color:

1. What are the most dominant gendered and racial discourses of mathematics ability raised in the African American and Latin@ college women's counter-stories?
2. To what extent do the women encounter these discourses in school policies, classroom structures, and interpersonal relationships throughout their mathematics experiences?
3. What strategies do the women employ in navigating these discourses and negotiating mathematics success at the intersections of their gender and racial identities?

### **3.2 Literature Review**

This section presents a review of relevant literature starting with the relation between gendered and racial discourses in mathematics and opportunities for success among women, African Americans, Latin@s, and other marginalized populations in mathematics. Two bodies of literature are then discussed to highlight findings from studies that examined participants' negotiations of discourses of mathematics ability with

their gender and race respectively. The review concludes with a discussion of the affordances and limitations of these studies.

### **Negotiating Racial Discourses of Mathematics Ability**

Studies have illustrated how systems of power in mathematics result in gendered and racialized struggles among marginalized groups (e.g., African Americans, Latin@s, women) to maintain and prove their academic legitimacy to others (Barnes, 2000; Berry, 2008; Esmonde et al., 2009; Gutiérrez, 2002; Gutstein, 2003; McGee & Martin, 2011; Mendick, 2006). From a racial standpoint, Martin (2000) highlights how sociopolitical influences in schools and classrooms structure inequitable opportunities for the development of positive mathematics identities among African Americans and other students of color. Thus, mathematics is a *racialized form of experience* for students of color in mathematics such that “race and the meanings constructed around race become highly salient” (Martin, 2006, p. 198). Other equity scholars in mathematics education have examined mathematics as a gendered form of experience in light of women’s underachievement and underrepresentation as well as the valuing of masculinized norms of mathematical engagement (Barnes, 2000; Fennema et al., 1998; Mendick, 2006). However, marginalized populations in mathematics including African Americans, Latin@s, women, and gender-nonconforming students are differentially positioned along the “racialized [and gendered] hierarchy of mathematics ability” (Martin, 2009, p. 297) better understood when attending to their experiences at intersections of their identities.

In a post-structural analysis of mathematics counter-stories, Stinson (2008) presented how his research participants (sub)-consciously negotiated sociocultural discourses of mathematics ability as African American men. Findings from Stinson’s

(2008) analysis illuminated how discourses of the “male African American,” the White/Black racial binary, and schooling deficiency and rejection framed the five young African American men’s negotiations of academic (and mathematics) success. Stinson (20008) argued that, in general, the African American men’s construction of positive mathematics identities reflected successful negotiations of the “White male math myth” discourse that socially constructed mathematics ability as raceless and an equal opportunity for all. Such innate discourses of mathematics ability, however, are manifestations of colorblind racism that stem from systems of white privilege operating in mathematics (Bonilla-Silva, 2003; Lewis; 2004; Martin, 2009, 2013).

McGee and Martin (2011) examined the co-construction of mathematics and racial identities among six academically resilient, Black<sup>8</sup> mathematics and engineering college students through discourse analyses of their life stories. These Black college men and women discursively engaged in stereotype management as responses to existing racial stereotypes of their limited mathematics ability and non-academic behaviors. Agency among the Black college students was evidenced in resistance against these racial stereotypes (or discourses) of mathematics ability such as cultural-code switching in academic spaces, ensuring their academic performance is up to standards (“always on point”), and pushing for success to become role models of successful Black mathematics and engineering students. Other CRT scholars have similarly documented such strategies among Black middle and high school students in navigating mathematics as a racialized space such as establishing a sense of “otherness” to separate themselves from lower-

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<sup>8</sup> I use the term “Black” (instead of African American) here to be consistent with the cited authors’ language choice.

achieving Black boys and using critical math literacy” to construct counter-stories to challenge deficit discourses about Black men in their community (Berry, Thunder, McClain, 2011; Terry, 2011).

Similar scholarship by Varley Gutiérrez, Willey, and Khisty (2011) and Oppland-Cordell (2014) explored Latin@ students’ negotiations of their identities with racial discourses in mathematics. Varley Gutiérrez and colleagues (2011) foregrounded the voices of third- to sixth-grade urban Latin@s in an afterschool mathematics program by examining their mathematics counter-stories particularly in relation to their cultural identities and language. Findings from their study revealed student narratives of resistance toward “mathematics-is-numbers” views of school mathematics and how discourses of being “good at mathematics” shaped their positive identities as mathematics learners. Although race was not the focus of the analysis, the Latin@ students’ counter-stories acknowledged the affordances of English-Spanish bilingual fluency as a cultural resource in their mathematics learning that ran counter to institutional structures (e.g., school policies, testing) privileging English-only forms of mathematics success.

Oppland-Cordell (2014) conducted a multiple case study of two urban Latin@ undergraduate students’ mathematics and racial identity constructions throughout their participation in a culturally diverse calculus workshop. Through a cross-case analysis of participants’ mathematics counter-stories, Oppland-Cordell (2014) detailed how the two urban Latin@ students shifted their workshop participation in tandem with their discursive constructions of positive identities as Latin@ mathematics students. The counter-stories raised forms of resistance toward their prior racialized experiences (e.g., teachers’ deficit views of Latin@ students, dealing with unmotivated Latin@ peers) and

discourses on acceptable ways of doing mathematics that allowed the urban Latin@ students to carve productive opportunities for themselves to participate in the calculus workshop.

### **Negotiating Gendered Discourses of Mathematics Ability**

Analogous to Stinson's (2008) racial analysis of sociocultural discourse negotiations, Mendick (2006) examined young college students' narratives of pursuing postsecondary mathematics from a gender lens of analysis on how mathematics ability is discursively constructed as "natural, individual, and masculine" (p. 204). Using individual student interviews, Mendick (2006) detailed how 43 college men and women across three British school sites negotiated gendered discourses of "good at maths/not good at maths" as mathematics students. Mendick's (2006) study captured how the college students discursively engaged in *gender identity projects* such that they were simultaneously doing gender and, more specifically, doing masculinity, in choosing mathematics (Mendick, 2003).

With mathematics socially constructed as a masculine domain, Mendick (2006) described how college women who identified as being "good at maths" adopted strategies such as selectively sharing academic achievements and not accounting for their feminine identities in relation to their mathematics success. While some college men successful in mathematics self-identified as "mathematicians" with innate mathematics ability as opposed to "non-mathematicians," other college men discursively engaged in a "new mode of school student masculinity" (Mendick, 2006, p. 73) characterized by outwardly or secretly working hard at mathematics with aims of professional advancement. Mendick (2006) captured how effortful success came to be the more dominant form of



masculinity in doing mathematics compared to the natural talent among “socially incompetent mathematicians.”

The British college men and women in Mendick’s (2006) study, thus, were discursive subjects who negotiated their gender identities with masculinized discourses of mathematics success. The power of mathematics ability -- a vehicle for career advancement in British society -- gave rise to competing forms of masculinity in doing mathematics with college women having to “prov[e] something to others” while college men navigated conflicting discourses of “authentic intelligence” and “hard work.” Analogous to the African American men’s raceless views of mathematics success in Stinson’s (2008) study, some of the British college men and women’s reflections of mathematics ability as innate and unassociated with gender are manifestations of gender-blindness that stems from the masculinized power of mathematics and thus perpetuates sexist and gender-normative discourses of mathematics ability (Acker, 1990).

Barnes’ (2000) ethnographic work in an accelerated Australian high school calculus classroom complements Mendick’s (2006) study, analyzing how mathematics success is discursively produced vis-à-vis gendered interactions. Using lesson observations as well as student and teacher interviews, Barnes (2000) detailed the discursive formation of gendered student subgroups including the Mates and Technophiles who represented dominant and subordinate masculinities respectively in the calculus classroom. These subgroups of boys in the classroom align with Mendick’s (2006) findings of competing masculinities in mathematics: the Mates represented the hegemonic masculinity of athleticism and hard work while the Technophiles embodied a “rational form of masculinity” through strong mathematics ability. The Mates and

Technophiles employed strategic moves in negotiating gendered discourses of academic and social competence to protect their mathematics status in the classroom.

### **A Call for Intersectional Analyses of Mathematics Experience**

Despite these analyses of marginalized student groups' negotiations of gendered and racialized discourses of mathematics ability, mathematics education scholars assert that there remains a need for research that explores such discursive negotiations at different intersections of students' social identities for more nuanced understandings of their mathematics experiences (Esmonde, et al., 2009; Martin 2009; Oppland-Cordell, 2014). Students are at junctures of multiple, yet often contradictory, discourses of mathematics success upheld by institutions (e.g., schools, classrooms), other individuals (e.g., peers, teachers), and society at large (Barnes, 2000; Stinson, 2008). The nature of these discourses varies when considering different intersections of mathematics students' identities including class, gender, and race. Martin and McGee (2011), for example, acknowledged room for further analysis in their study of academically resilient Black students' stereotype management in relation to other social identities besides race. Terry (2011) similarly commented on how such intersectional analyses would allow for explorations of the gendered variation among the urban Black male participants' experiences in his study and thus further "theoretical discussion[s] of academic identities vis-à-vis Black masculinity" (p. 96). In their respective studies, Mendick (2006) and Stinson's (2008) findings capture how students are constantly negotiating gendered and racial discursive binaries of mathematics ability including "masculine/feminine" and "White/Black" respectively. Stinson (2008), furthermore, highlights the complexity of such negotiations of mathematics success when acknowledging how these "[discursive]

subjects live at *intersections* of these binaries” (p. 992, emphasis added) with saliency of the binary dimensions varying across contexts and individuals. Thus, extant scholarship detailing marginalized students’ discursive negotiations of mathematics success in relation to a single identity axis of oppression (e.g., race, gender) sets the stage for future work with nuanced analyses of how students co-construct mathematics identities at different intersections of their social identities.

### **3.3 Theoretical Framework**

This section elaborates the theoretical perspectives that informed the study’s data collection and analysis. Race is conceptualized as a social construct that intersects with property rights giving rise to systemic inequalities (including education) in the United States among people of color (Ladson-Billings & Tate, 1995). Gender is theorized as a social construct discursively produced or performed differently across individuals and contexts (Butler, 1990). With a focus on intersections of gender and race, this study drew on the tenet of intersectionality from critical race theory and Latin@ critical theory to detail gendered and racialized dimensions of mathematics experience. Post-structural theory guided the identification of discourses encountered in participants’ mathematics experiences and negotiations of mathematics success with discursive positioning along the gendered and racialized hierarchy of mathematics ability.

#### **Critical Race Theory**

Critical race theory (CRT) in education is a perspective that “foreground[s] and account[s] for the role of race and racism” (Solórzano & Yosso, 2002, p. 25) in efforts to disrupt racism and other intersecting systems of societal oppression (e.g., sexism, classism) in schools and classrooms. Methodologically, CRT allows for analytical

construction of counter-stories, or narratives from African Americans, Latin@s, and other marginalized racial groups whose experiences are often overlooked (Solórzano & Yosso, 2002).

One of the CRT tenets guiding such counter-story analyses is the intersectionality (Crenshaw, 1991) of experience that considers how intersections of race, gender, class, and other identities shape these narratives of oppression and resistance. Use of intersectionality in educational research “challenges the separate discourses on race [and] gender... by showing how these [two] elements intersect to affect the experiences of students of color” (Solórzano & Yosso, 2002, p. 24).

As a “theoretical cousin” to CRT, Latin@ critical race theory (LatCrit) addresses the multidimensionality of identity particular among Latin@s with analytical considerations of experience at intersections of race, sex, gender, class, and other social dimensions (Solórzano & Bernal, 2001). LatCrit complements CRT by considering issues of culture, immigration, and language among Latin@s that often go unexplored by critical race theorists (Bernal, 2002). With an intersectional analysis, this study used CRT and LatCrit to examine the extent to which mathematics is a gendered and racialized experience through the construction of counter-stories from first-year African American and Latin@ students at a predominantly white institution.

### **Post-Structural Theory**

Post-structural theory’s conceptualizations of *discourse* and *power* were used to frame the study’s analysis of African American and Latin@ students’ mathematics counter-stories. The study draws on Scott’s (1988) definition of discourse as a “historically, socially, and institutionally specific structure of statements, terms,

categories, and beliefs” (p. 35). This definition captures how discourses structure behavior and language in ways that highlight the “surface linkages between power, knowledge, institutions, [and] intellectuals... as these intersect in the functions of systems of thought” (Bové, quoted in St. Pierre, 1990, p. 54). In this study, discourses refer to norms and behaviors of mathematics ability structured by racism, sexism, and other systems of inequality that shaped first-year African American and Latin@ college students’ mathematics experiences. Counter-stories are, therefore, constructed to detail the varying influences of discourses of mathematics ability related to gender, race, and their intersections.

Power is theorized as multiple systems of relations in constant flux across individuals and contexts (Foucault, 1997/1984). Halperin (1995) writes, “Power is thus a dynamic *situation*, whether personal, social, or institutional” (p. 17). Discourses are, therefore, contextual manifestations of these varying power relations that inform one’s positioning across these intersecting systems at different moments. Foucaultian thought asserts that power comes with resistance in which strategic moves are adopted in reaction to sociocultural discourses of opportunity and oppression. Such agency in these reactions, however, is within certain limits maintained by these power relations that perpetuate the status quo in society (St. Pierre, 2000).

Under post-structural theory, individuals are conceptualized as discursive subjects whose identities are socially constructed through their ongoing negotiations of sociocultural discourses and power relations (St. Pierre, 2000; Walkerdine, 1995). Subjects’ identities, therefore, are in a perpetual state of flux and produced as discursive responses to the dynamically changing power relations in everyday society. Post-

structural theory goes further to describe how identities and systems of meaning are mutually produced with such “meaning[s]... strategically reinterpreted, reworked, and deferred since there is no referent for the subject” (St. Pierre, 2000, p. 503). Thus, these theoretical ideas can be applied to understand how marginalized groups including African Americans and Latin@s make meaning of mathematics success as well as how such meanings are gendered and racialized in the co-construction of their mathematics and social identities.

Using a sociocultural lens, Martin (2006) defines mathematics identity as:

dispositions and deeply held beliefs that individuals develop, within their overall self-concept, about their ability to participate and perform effectively in mathematical contexts... A mathematics identity encompasses a person’s self-understanding of himself or herself in the context of doing mathematics (p. 326).

By applying a post-structural lens to Martin’s (2006) definition, mathematics identities are social constructions constantly negotiated across different contexts in response to discourses in mathematics shaped by systems of inequality including racism and sexism (Berry et al., 2011; Boaler & Greeno, 2000; Esmonde, 2009; Mendick, 2006; Stinson, 2008). This informs the intersectional lens of analysis used to examine African American and Latin@ college students’ mathematics experiences and thus detail how participants co-constructed their social and mathematics identities as responses to discourses of mathematics ability particularly at intersections of gender and race.

Drawing on Martin (2009) and Mendick’s (2006) scholarship, this study theorizes mathematics as a source of power that structures a gendered and racialized hierarchy of ability aligned with society’s inequitable opportunities for dominant and marginalized groups. Mathematics counter-stories, thus, are analytical manifestations of how African American and Latin@ college women and men engaged with discourses of mathematics

ability and differentially positioned themselves along this hierarchy. Such discursive negotiations offer insight into African American and Latin@ college students' strategic moves in navigating these discourses throughout their pursuits in mathematics.

These theoretical perspectives collectively informed the study's methodology that addresses the need for scholarship in mathematics education exploring the intersectionality of mathematics experience among historically marginalized student populations. From an ideological standpoint, post-structural theory complemented CRT's counter-storytelling methodology in the study to identify racial, gendered, and other social discourses of mathematics ability across participants' reflections of their mathematics experiences. The gendered and racialized power of mathematics ability, under post-structural thought, is maintained through perpetuation of such marginalizing discourses about African Americans, Latin@s, and women in mathematics. Coupling this with a sociocultural view of mathematics identities, this study examines the institutional and interpersonal sources of these discourses across participants' counter-stories used to make meaning of their mathematics experiences and identities. The intersectionality tenet of CRT and LatCrit focuses this counter-story analysis by exploring the variation across participants' strategies in negotiating their mathematics identities with these discourses particularly at intersections of gender and racial identities.

### **3.4 Methods**

Critical race theory (Solórzano & Yosso, 2002) informed the design of the research study including the analytical construction of first-year African American and Latin@ college students' mathematics counter-stories. With a post-structural lens of analysis, college students of color's mathematics counter-stories were examined as

discursive productions mapping onto instances of disconnect and marginalization as well as affirmation and empowerment that subsequently impacted the construction of their mathematics identities at intersections of gender and race (Martin, 2009).

A qualitative case study methodology (Miles & Huberman, 1994; Yin, 2003) was employed such that the African American and Latin@ students' mathematics counter-stories are the "cases," or units of analysis, used in detailing the extent to which mathematics was a gendered and racialized experience for them. In efforts to gain holistic understandings of participants' mathematics experiences, the African American and Latin@ students' mathematics counter-stories were constructed by triangulating multiple data sources including mathematics autobiographies, individual interviews, and focus group discussions. The analytical construction of these mathematics counter-stories address the study's research questions by exploring what were the most dominant gendered and racial discourses of mathematics ability raised, when and where participants encountered them, and how they navigated them in co-constructing their mathematics and social identities.

### **Research Context**

This study was conducted in spring 2013 at a large, public four-year university located in the northeastern United States. According to the university's 2013 institutional profile, the average Math SAT score for all first-year, full-time undergraduate admits from fall 2012 was 605 out of 800. African Americans and Latin@s comprised less than a quarter of the fall 2012 undergraduate student population. While African Americans made up less than 10% of full-time students in fall 2012, Latin@s represented about 13%. Men and women in general enrolled at the university at comparable rates.



Of the first-year undergraduate population from fall 2006, African Americans and Latin@s graduated from the university within four years at rates of 40% and 34% respectively. African Americans and Latin@s earned a baccalaureate degree at rates ranging between 10 and 15 percent by the end of the 2011-2012. Considering only about 10% of the university's conferred degrees were in STEM fields (e.g., engineering, mathematics/science, physical sciences), an even smaller percentage of the conferred STEM degrees were conferred to African Americans and Latin@. African Americans and Latin@s comprised about 6% of the university's full-time faculty in fall 2012. Latin@ women was the least represented group among full-time faculty members, a total of 26 with and without tenure in fall 2012.

### **Participants**

Eight first-year college students pursuing math-intensive academic majors at the same university were recruited for the research study. This included two African American women, two African American men, two Latin@ women, and two Latin@ men. All participants were drawn from a STEM support program ran at the university. By the start of data collection, all participants had taken at least one college mathematics course (e.g., algebra, pre-calculus, calculus) during their first semester at the university.

This article focuses on findings related to the two African American women and two Latin@ women. To address the research questions on mathematics as a gendered and racialized experience, these four participants were purposefully selected with the intent to capture at least some variation across intersections of their gender and racial identities.

The following table presents profiles for these four study participants. This table outlines participants' intended STEM majors, high school student demographics, most

recently completed college mathematics course, and career goals. All participants' initial STEM major interests continued throughout the study with the exception of Rachael who transferred out of the university's engineering program to pursue a public health degree instead. The variation across participants' high school demographics is noteworthy especially when considering their respective experiences of transitioning into a predominantly white university space. Each participant had at least completed college pre-calculus during their first semester with calculus as the first course requirement across their intended STEM majors. Despite taking calculus during their second college semester, Rachael and Tracey had prior calculus experience in high school and a summer bridge program for incoming STEM students at the university, respectively.

**Table 3.1 Participant Profiles**

<b>Pseudonyms</b>	<b>Race &amp; Gender</b>	<b>Intended STEM Majors</b>	<b>High School Student Demographics</b>	<b>Completed College Mathematics</b>	<b>Career Goals</b>
Kelly	African American woman	Biochemical engineering	Predominantly white, Title I <sup>9</sup>	Advanced pre-calculus	Engineer
Rachael	African American woman	Biomedical engineering (initial); Public health	Predominantly Black	Calculus I for STEM majors	Pre-medicine
Lauren	Latin@ woman	Computer science	Predominantly White	Advanced pre-calculus	Undecided
Tracey	Latin@ woman	Mathematics	Predominantly Latin@	Calculus I for STEM majors	Mathematics teacher

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<sup>9</sup> Title I is a classification under the Elementary and Secondary Education Act of 1965 for schools that are recipients of federal funding intended to close the achievement gaps between financially disadvantaged and other students in the United States.

### **STEM Support Program**

Participants for the study were recruited from a non-residential student support program aimed at increasing underrepresented racial minorities' completion of baccalaureate degrees in STEM fields. The university program's support services focus on providing underrepresented college students with co-curricular activities and networking opportunities to advance their academic and professional development in STEM. Some of the STEM support program's co-curricular offerings included tutoring for STEM gateway courses, yearlong peer mentoring, and skill-building workshops (i.e. note taking, study strategies, time management). Support program leaders and student participants meet on a monthly basis for special-interest programming such as guest lectures, networking functions, and panel discussions aligned with students' academic and career goals in STEM. In addition, support program participants are provided with multiple opportunities to explore options for their future career development in lab research, graduate school preparations (e.g., annual conference), and internships/externships (e.g., shadowing programs).

### **Data Collection**

Three data sources were used to construct the first-year African American and Latin@ college women's mathematics counter-stories: (i) mathematics autobiographies, (ii) individual interviews, and (iii) focus group discussions. This section explores the nature of each data source and how it contributed to answering the research questions on mathematics as a gendered and racialized experience for the African American and Latin@ college women participants.

**Mathematics autobiographies.** Participants wrote two-to-three paragraph autobiographies on their previous mathematics experiences during high school and college. In the autobiographies, participants reflected on their most and least favorite mathematics class experiences with details on the nature of their participation, relationships with teachers, and classroom structures and interactions. Participants provided similar reflections on their most recently completed college mathematics courses at the university.

The mathematics autobiographies were submitted prior to participants' individual interviews. Stimulus excerpts were used during interviews to probe participants about connections between their mathematics experiences and racial and gender identities. In addition, high school and college mathematics reflections were used to probe participants on what being successful looked like across these contexts, how these messages of mathematics success were communicated, and what strategies they employed to meet these standards of success.

**Individual interviews.** Each participant completed a 90-minute, semi-structured individual interview focused on four themes for their mathematics experiences, including high school encounters, college coursework, STEM support program participation, and views on women and racial minorities in mathematics and STEM at large. All interviews were audiotaped and transcribed. As previously mentioned, the interviews drew upon participants' mathematics autobiographies to examine gendered and racialized influences on high school and college mathematics experiences including their STEM support program involvement and pursuits of math-intensive majors. Some questions used to probe these gendered and racialized dynamics across the first-year African American and

Latin@ college women's mathematics experiences included, "How do you feel as though [Insert participant's intersectional identity] are encouraged or discouraged from pursuing mathematics?" and "Why do you think so many fellow [Insert participant's intersectional identity] like yourself do not make it in mathematics?"

**Focus group discussions.** After the individual interview, participants completed a focus group discussion with three-to-four other participants to motivate peer discussions on African American and Latin@ women and men in mathematics and STEM at large. Each focus group participant was paired with another participant of the same intersectional identity. These focus group pairings were intended to establish safe, welcoming discussion environments such that participants would not feel tokened and could possibly relate to at least one other participant's shared perspectives as well as highlight differences between their experiences. In addition, this design allowed for variance to arise within group so that their voices would not be essentialized. Finally, by having two different intersections represented, this focused the analysis on similarities and differences between intersectional groups as well. All focus group discussions were audiotaped and transcribed.

During each focus group discussion, participants were presented with five mathematics student narrative excerpts from four mathematics education articles on marginalized racial and gender groups' mathematics experiences (Berry et al., 2011; Lombardi, 2011; Mendick, 2005; Stinson, 2008). Participants were asked to read these five excerpts and select one or two with which they either strongly associated or disassociated based on their mathematics experiences. These excerpts, drawing on Stinson's (2008) methodology, provided participants with the language to engage in

meaningful, critical conversations surrounding gender and race in mathematics.

Participants were probed for any gendered and racialized significance in their reactions to the stimulus narrative excerpts. Some probing questions included “To what extent does diversity play a role in your college mathematics experiences at the university?” and “What are some examples from your high school and college experience when you felt your mathematics ability judged based on your gender and/or race?”

In addition, participants were asked to discuss issues regarding African American and Latin@ women’s current underrepresentation as well as these groups’ projected future participation and success in STEM including mathematics. Participants were presented with questions such as “How has your STEM support program involvement, if at all, influenced how you see yourself as a [Insert participant’s intersectional identity] in STEM?” and “As a [Insert participant’s intersectional identity] pursuing a math-intensive STEM degree, how do you see the future of women and underrepresented minorities in STEM including mathematics? What ideas or experiences bring you to raise this claim about the future diversity of STEM?”

### **Data Analysis**

These three data sources were used to write counter-stories of two African American women and two Latin@ women’s mathematics experiences. A cross-cutting intersectional analysis of these counter-stories was employed to examine patterns of how the first-year African American and Latin@ college women constructed mathematics identities as responses to discourses of mathematics ability related to gender, race, and their intersections.

Using a post-structural and intersectional lenses of analysis, the African American and Latin@ participants' counter-stories were openly coded for discourses in mathematics. I openly coded for gendered and racial discourses (Bowleg, 2008). Axial codes were used to identify the institutional and interpersonal contexts in which participants encountered these discourses, strategies for navigating them, and consequences of the strategies (Strauss & Corbin, 1998).

One of the key aspects of intersectional analysis in qualitative research is making participants' implicit experiences of intersectionality explicit, including when participants do not report them (Bowleg, 2008). To address this, mathematics counter-stories were examined for gendered and racialized "subtexts" of how African American and Latin@ participants discursively constructed meanings of their mathematics experiences particularly at the intersections of gender and race (Banning, 1999). Open and axial coding of counter-stories and their subtexts, thus, served to illuminate the intersectionality across participants' discursive negotiations of mathematics as a simultaneously gendered and racialized experience.

**Validity.** Triangulation of collected data, memoing, an independent coder, and member checking validated the study's findings. Excerpts from the participants' mathematics autobiographies were incorporated into the individual interviews and focus group discussions to clarify and probe meanings of key statements. This sequential data collection reinforced and provided more nuance of prior findings.

Analytical memos were written throughout the data collection and analysis processes. All memos were dated to trace the development of data interpretations including possible themes, areas of needed clarification, and key connections to the

research literature. Memos and annotated transcripts were used to develop the open and axial coding schemes as well as track instances of confirming and disconfirming evidence (Creswell & Miller, 2000). Disconfirming evidence not only informed any necessary coding scheme revisions, but also allowed for making meaning of these inconsistencies in relation to the research questions.

A colleague independently coded excerpts from the transcribed data to confirm the accuracy of the open and axial coding schemes. A detailed codebook containing descriptions and sample instances of each open and axial code was provided. A varied assortment of excerpts corresponding to different open and axial codes was selected for this independent coding task. Any coding disagreements were discussed during code reconciliation meetings until they were resolved and necessary coding scheme adjustments were made.

Member checking the accuracy of the transcripts, coding scheme, and data interpretations was also used to strengthen the validity of the study's findings. Two member checks were held with participants at the end of the spring 2013 semester. Participants were presented with coded excerpts across the four data sources and asked to reflect on the accuracy in terms of the transcription and interpretation. Insights gleaned from these member-checking procedures informed necessary revisions to the coding scheme and study's preliminary findings.

**Researcher identity and positionality.** As a Latin@ man who graduated as a mathematics major and researches mathematics experiences of underrepresented populations in STEM, I brought an understanding of my positionality in pursuing data analysis and interpretations with strong subjectivity to develop nuanced understandings



of mathematics as a gendered and racialized experience. I was aware that my Latin@ racial identity allowed me to relate to feelings of underrepresentation, academic disadvantage, and struggle that Latin@ participants may have experienced with mathematics. Similarly, my identity as a cisgendered man afforded me opportunities to connect with participants whose mathematics ability as men may have not been questioned or undermined compared to their women counterparts.

Despite these mutual understandings in terms of gender and race exclusively, I also acknowledge my varying social distance from participants in experiencing mathematics as a cisgendered Latin@ man rather than from another intersectional perspective such as a trans\* African American man or Latin@ woman. Awareness of my shifting positionality throughout the study played an important role in identifying moments “where self and study [were] intertwined” (Stinson, 2008, p. 987). As Kincheloe and McLaren (2003) write, “Critical qualitative researchers who understand the relationship between identity formation and interpretive lenses are better equipped to understand the etymology of their own assertions – especially the way power operates to shape them” (p. 296). Thus, consciousness of my positionality as a Latin@ man in mathematics allowed me to connect in different ways with participants’ experiences as well as be willing and open to learn from them.

As a four-year employee in the university office overseeing the STEM support program, I approached the study with strong familiarity of the program and its leadership as well as ongoing visibility to student members during monthly meetings and events. My indirect affiliation to the STEM support program as well as the study’s confidentiality clause was communicated to all participants to re-assure that their

continued program participation would not be jeopardized in light of their shared reflections on the membership experience. In addition, mutual identification with participants as a person of color who also pursued a math-intensive STEM major allowed for the establishment of intersubjectivity that built positive rapport and trust throughout the study (Glesne & Peshkin, 1999; Lincoln & Guba, 1999). Such participant-researcher connection captures the use of my “multiple identities as an interaction quality” (Berry, 2008, p. 472) to create welcoming spaces for the first-year African American and Latin@ college women to share and reflect on their mathematics experiences.

### **3.5 Findings**

This section presents the four cases of the first-year African American and Latin@ college women participants’ mathematics counter-stories. The findings detail the women of color’s mathematics experiences from high school and college as well as how they negotiated their identities with discourses of mathematics ability related to gender, race, and their intersections. After this, a cross-case analysis highlights emergent themes across these four women’s mathematics counter-stories with particular attention to the most dominant discourses of mathematics ability that were raised, how participants were subjected to them (e.g., institutional structures, interpersonal relations), and what strategies they employed in negotiating these discourses with their social identities and mathematics success.

#### **3.5a Kelly**

Kelly is a first-year African American college woman who decided to pursue a biochemical engineering degree in light of her mother’s encouragement and watching her father’s work as an electrical engineer. Self-identifying as a “sciencey-math person,”

Kelly described realizing that she liked mathematics at the end of high school. She views mathematics as being “always doable” for her. As a mathematics student, Kelly saw herself as being “good at math” by comparing her academic performance to others including college peers and her sister. Her sister played a key role in making this realization as Kelly earned a higher mathematics score on the SAT and regularly helped her with mathematics problems in high school. It is important to note that despite such comparisons, Kelly discussed actively trying to be “humble” by not comparing herself academically and mathematically to others. Kelly also valued building relationships with high school mathematics teachers particularly those who she saw as being approachable and advanced her learning.

Her first semester of college was when she took her favorite mathematics class, pre-calculus. Kelly contrasted college pre-calculus with high school mathematics as it was in college when she “really started to understand” the mathematics. Even though Kelly knew that she was “good at math” since elementary school, pre-calculus was a re-affirming experience as the college mathematics course was “very manageable” despite others’ claims that it would be extremely difficult.

I kinda just like said ‘Okay if everyone is saying that it’s really hard and I’m doing really well, then that must mean that either I’m good at math or either they are bad at math.’ And I don’t wanna think that someone else is bad so I just said I’m good at math. (Individual Interview)

This reflection is noteworthy as we see Kelly invoking the discourse of mathematics ability as innate rather than based on effort or work. Such innateness of ability allows Kelly to make meaning of performance in such a challenging class like college precalculus to be an indication if one is “bad at math” or “good at math.” More

specifically, Kelly compares her strong performance in college precalculus to others' perceptions of the course as "extremely hard" to claim that she must be "good at math."

When asked how her college pre-calculus classmates may have perceived her as a mathematics student, Kelly felt as though they possibly thought that she "really liked the class" and was "good at math." Kelly attributed this to her classroom behaviors of sitting toward the front during lectures and being "the only one" frequently asking questions and volunteering homework solutions during recitation<sup>10</sup> sessions. She contrasted these behaviors to those of other students who seemed like they "weren't that into it or... just didn't like math" as they were asleep and less willing to participate during class. Thus, Kelly discursively separates herself from others who "didn't like math" based on these mathematics classroom behaviors.

It is noteworthy how even though her high-performing classmate Eric engaged in off-task classroom behaviors such as not taking notes and watching videos on his cell phone, Kelly described him as being "really smart" and "really good" at the class. This disparity between why Kelly thinks others would perceive her as "good at math" and her perception of Eric as a mathematics student puts into question how gender, race, and

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<sup>10</sup> At the university, recitations are weekly 55-minute or 80-minute class sessions accompanying the lecture led by a graduate teaching assistant. The recitations are intended to be structured as student-driven discussions of homework and other assigned problems from lecture and/or collaborative problem-solving opportunities with groups of students working on challenging problem sets likened to Treisman's (1992) "math workshop" model.

other dimensions of identity shape peer perspectives of who can afford to engage in off-task behaviors without jeopardizing their status of mathematics ability in the classroom.

**Gendered discourses of mathematics ability.** Kelly acknowledged the existence of gendered stereotypes such that “society portrays guys as better, faster, stronger, everything” and how that impacts perceptions of academic ability. For example, she reflected on experiencing peer distrust of her contributions as a woman during group tasks. Kelly described how “most of the time it’s... a male who wants to take over” and complete the entire project alone, bringing her to feel like her ideas were unwelcome or not worthwhile. She described how men often exude a sense of confidence that protects them from negative judgments whereas perceived humility would not lead to such protection:

If you talk to a male, like it doesn’t matter like sometimes it doesn’t matter the race because if you come off as confident about it, then they’re automatically gonna think ‘Oh they know what they’re doing. It doesn’t really matter. We don’t have to judge them.’ But if you come off as like very humble about it, they’re probably gonna think ‘They don’t know what they’re doing like anyway. So they might fail or they might prevail, but they’re probably leaning towards fail.’ (Focus Group Discussion)

Kelly’s comments illustrate how one is doing gender when doing mathematics with confidence of ability marked as masculine and humility as effeminate (Mendick, 2006). Thus, the ways in which women and men present themselves as doers of mathematics shape others’ gendered perceptions of their mathematics ability. This raises the extent to which women like Kelly must adopt masculinized approaches to doing mathematics in order to protect their status as mathematically successful especially in light of the discourse of men being better than women in mathematics. It is noteworthy how, despite Kelly’s claim of humility as a gendered vulnerability, she approaches mathematics

humbly by not underestimating the rigor of a class and not comparing her grades with others', thus positioning herself as being vulnerable to such negative judgments.

**Racial discourses of mathematics ability.** As a “straight-A student” before college, Kelly reflected on how her classmates at a predominantly black middle school picked on her and her sister for “acting white” due to their good grades and “proper” ways of speaking. She went on to explain how such teasing reflects how being good at mathematics or smart in general is perceived as the opposite of being cool among African Americans. Mathematics ability, thus, comes to be associated with whiteness under the racial discourse of African Americans wanting to be cool rather than smart and, as Kelly remarked, results in perceptions of African Americans not liking or not being good at mathematics. Kelly challenged this discourse by asserting that not all African Americans appealed to it since there are “different kinds of black people,” including those who act out to appear cool and those like herself who act “normal” rather than stereotypically black (e.g., talking “ghetto”).

These racialized perceptions of ability were encountered in Kelly's college engineering experience when classmates questioned if she completed homework problems independently.

Such underestimation of Kelly's ability brought her to purposefully not share grades with others to avoid receiving such negative judgments and being perceived as “trying to be better than them.” Kelly, in addition, described how she “didn't really let it [the racial discourse] apply” to her by remaining humble about her achievements (e.g., engineering school acceptance) and not comparing herself to others. However, it is interesting how

despite this claim, Kelly frequently compares herself academically and mathematically to her peers before and during college.

Furthermore, Kelly argued such low expectations of African Americans' mathematics ability may cause them to think that they do not like mathematics without trying to do it. This is a racialized dynamic that Kelly observed among her African American high school peers who she perceived to be good at mathematics. In addition, Kelly acknowledged that such racial underestimation may cause African Americans to feel as though they must "actually do work" and "prove themselves" in mathematics spaces. This reflection puts into perspective the racialized idea of who needs to work hard in order to be perceived as being good at mathematics a dynamic that seems to be unconsciously at play in Kelly's college precalculus class experience.

Kelly reflected on how African Americans may internalize messages of low expectations for their academic ability that in turn cause them to give up. To illustrate this idea, she shared an anecdote of a fellow African American engineering student at the university who wanted to transfer to a historically black college or university because she felt that the professors "taught only for the Asian students."

She felt as though the teachers, they taught only for Asian students like they went really fast and she just wasn't able to grasp the concepts as fast as them. And she felt as though if she went to a different school like a minority black school, she felt as though the teachers would know how to appeal to her and would know how to teach her what she needed to know. She felt kind of intimidated. She was like 'I couldn't study with all these Asian people because they're like really smart and like really good and I'm not gonna be able to like be up to their standards and that's not what I wanna do.' (Individual Interview)

Here we see how Kelly's friend observed the racial discourses of Asian Americans as being "really smart" and "really good at mathematics" operating in her STEM classrooms at the university. She saw these discourses as shaping the nature of professors'

instruction and student support that disadvantaged African Americans like her and can be used to explain Asian Americans' overrepresentation across her STEM classes. A racial hierarchy of ability was established in the STEM classrooms that brought Kelly's friend to develop a sense of inadequacy from comparing herself to Asian American classmates and consider giving up on the university's engineering program.

**Navigating intersections of gendered and racial discourses.** With the discourse of men being "expected to handle anything" compared to women, Kelly argued how a man taking multiple mathematics classes would be perceived less surprising than a woman, regardless of her race, doing the same amount of mathematics. Kelly's following reflection considered how such gendered expectations of a manageable mathematics course load are also racialized:

If it would have been a male, they would have been expected to take two maths and be fine with it even if they weren't as good at math. They are just expected to handle anything. And then I feel like if it was a minority, then they would probably get the same reaction [as a woman] because two maths are hard to take. (Focus Group Discussion)

It is noteworthy that Kelly perceived others' reactions of women and racial minorities taking multiple mathematics classes to be similar. This illustrates the influence of gendered and racialized discourses that women and minorities respectively are not good at mathematics. Kelly also seems to place being a woman and a racial minority at the same level of receiving negative judgment from others about mathematics ability. This can explain the uncertainty that Kelly, as an African American woman at the intersection of these gendered and racial discourses, expressed feeling when others seemed to underestimate her academic ability.

And that really saddens me because I don't really understand why like I don't know if it's because I'm a female or like because I'm African American... people



don't have confidence that I would be able to get the problem on my own... like I feel as though I am really smart, but they think I am not as smart as them when obviously I got the problem and you didn't. (Individual Interview)

Kelly's uncertainty on the gendered and/or racialized nature of this underestimation captures the emotional labor of African American women and other marginalized populations in managing the ambiguity of being at intersections of multiple discourses related to mathematics ability. She sees her family including her single mother and sister as a "support system" in negotiating these gendered and racialized discourses as an African American woman in college engineering. Kelly described how her mother was underestimated for her academic potential to become a nurse as well as her ability to raise two daughters without a husband. She appeals to her mother's success in nursing and the household in spite of others' judgments in guiding her approaches to managing the gendered and racial underestimation that she encounters as an African American woman in engineering. Her mother's influence on Kelly's academics is evident as she draws on her advice on "speak[ing] properly and not... talk[ing] ghetto" when responding to the racial discourse of white-acting successful African Americans well as not "rely[ing] on someone else" when responding to the gendered discourse of women's inferiority to men.

### **3.5b Rachael**

Rachael is an African American woman accepted into the university's engineering school as a biomedical engineering major. She transferred out of the engineering school after the first semester to pursue a pre-medical track as a double major in anthropology and public health. While seeing herself as generally being "okay at math," Rachael discussed having been a better mathematics student in high school than in college.

Building positive relationships with her teachers and classmates played a major role in her effortless success in high school mathematics. Geometry and calculus were her favorite high school mathematics classes because the teacher took the time to get to know her, believed in her potential as a future college student, and established a sense of “mutual respect” with her. In addition, the familiarity of her classmates in high school calculus allowed Rachael to more comfortably work together with them – one of her preferred ways of learning mathematics. This contrasted with Rachael’s experience in precalculus, her least favorite high school mathematics class, with younger, “cocky” students who she felt as though set the pace for the teacher’s instruction and asked “really good questions.” Rachael was intimidated by these younger classmates who negatively judged her for not being placed with her grade-level peers in more advanced mathematics classes. This dissuaded Rachael from actively participating so she would eavesdrop on her younger precalculus classmates’ discussions of the class material.

Although Rachael commented on how opportunities for building positive teacher and peer relationships were far and few between in college, she attributed much of her academic struggles at the university to not trying hard enough. Seeing herself as a “good student in high school” without really “trying” in mathematics, Rachael thought she could do the same in college. Rachael reflected on how her lack of effort in college mathematics caused her to fail her calculus course for STEM majors that she then re-took the following semester. It is noteworthy how Rachael took full responsibility for her difficult transition into college mathematics despite her critical views on encountering favoritism from teachers and judgment of ability from peers.

Her second calculus professor, for example, seemed to have favorites in the class who kept track of time for him and always answered his questions during lectures. Rachael reflected on how the professor knew these favorite students' names and probably thought they were "really serious about learning" since they sat toward the front of the classroom. She also recalled a specific instance when she felt "completely shut down" by the professor after attempting to answer one of his questions during the lecture. Such favoritism and dismissal of her contribution brought Rachael to not actively participate in college mathematics classes or seek professors' help during office hours.

**Gendered discourses of mathematics ability.** Rachael draws on the discourse of women not being good at mathematics to characterize the gendered power of mathematics ability and thus make meaning of women's underrepresentation in mathematics classes and encountered criticisms of being "smart for a girl." She reflected on how the underrepresentation of women in mathematics and science classes may cause them to feel as though they are not expected to be good at these subjects. For example, she recalled how a high school peer was the only girl in a physics class and would often be told, "You're smart for a girl. It's good that you made it for a girl." Another peer praised for taking AP calculus early as a junior was a fellow minority woman taking the class with a large number of boys. Rachael used this interaction to argue that if the praised student had been a boy, he would have probably received this praise less humbly than her friend did. Her analysis of this interaction aligns with Kelly's discussion about gendered ways of doing mathematics such that confidence of mathematics ability is discursively masculinized and valued over humility in protecting one's status.

To illustrate this discursive masculinization of mathematics ability, Rachael commented on the arrogance that she observes particularly among boys who see themselves and/or are perceived as being good at mathematics. She, for example, recalled how these arrogant boys in high school would make sexist remarks to girls such as, “She doesn’t need to be in this class. She doesn’t need to pursue success because a man will just provide for her.” She made meaning of these sexist remarks in relation to the gendered discourse of women being dependent on men. Rachael commented on how these remarks operated to protect the boys’ high status in mathematics and thus maintained the gendered power of mathematics ability in her high school.

In addition, Rachael reflected on how the impact of gendered expectations of mathematics ability seems to be more pronounced during stages of career preparations including college. She drew from stories of other individuals’ encounters with such gendered biases to illustrate how a “divide starts to grow” between women and men such that “a lot of female people are turned away from mathematics.” For example, Rachael shared having read about a transgender, or trans\*, man at an Ivy League institution who received different treatment from his mathematics professor before and after his gender transition surgery.

There was like this really hard question and she<sup>11</sup> answered it and nobody else answered it and her professor was like ‘Your boyfriend probably answered that for you like at home doing your homework last night or something.’ So they just like didn’t think she could do it and when she became a man and she changed her name and they like didn’t know who she was, they treated her differently so that was really interesting because she came at it from two different perspectives, from the female and the male perspective. (Individual Interview)

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<sup>11</sup> I am quoting Rachael’s use of she/her/hers pronouns in this interview excerpt even though it would be more gender-appropriate to use he/him/his pronouns throughout.

Such narratives capture how the discourse of women not being good at mathematics may shape educators' gendered perceptions of mathematics ability and result in differential opportunities of mathematics learning for students. These gendered views of mathematics ability, in turn, contribute to the masculinization of STEM spaces including classrooms and the workplace.

**Racial discourses of mathematics ability.** Rachael also reflected on the racialized power of mathematics ability in her high school. Students' perceived intelligence was based on students' mathematics and science achievement such that tracked class placements in served as proxies for their "levels" of intelligence. This was, however, racialized considering how African Americans and Latin@s were underrepresented in more advanced mathematics. With this line of reasoning, students who were in lower-tracked classes, including African Americans and Latin@s, come to be perceived as being less intelligent than their higher-tracked peers and thus innately bad at mathematics. Much like Kelly's reflections on being policed for "acting white," whiteness is operating here. Colorblind views of mathematics ability coupled with students of color's lower mathematics class placements lead to views of African Americans and Latin@s as being innately disadvantaged for success as mathematics success (Battey & Leyva, under review, 2015b).

To illustrate this further, Rachael looked back on her college application process when she was accepted into an Ivy League school while another "really smart" peer was not. Others discounted Rachael's admission by claiming that she was accepted solely because she was African American since her mathematics grades were not as high as those of the rejected peer. This experience brought Rachael to challenge how intellectual

authority is bestowed onto individuals based solely on mathematics achievement through questions such as, “Math is a hard subject, but like why is that it’s so like praised?” and “Like if you’re good at math, then all of your problems are solved?”

The peer’s discrediting of Rachael’s Ivy League acceptance, moreover, communicated how African Americans and other racial minorities supported by affirmative action policies do not earn college admissions based on academic merit. The racialized idea of mathematics ability as associated with whiteness, thus, shaped this peer’s logic that a higher grade in high school pre-calculus class would have proved Rachael’s intellectual ability and thus better positioned her in having academically earned her admission as an African American applicant. Such encounters with racialized perceptions of African Americans’ academic ability in high school brought Rachael to selectively share her accomplishments with others including college acceptances. Although Rachael purposefully engages in this silencing to protect her academic identity as an African American woman from others’ negative judgments, it is important to note that this also maintains the racial status quo of academic ability perceptions that positions African Americans and other racial minorities as being less capable.

Much like Kelly, Rachael shared about being criticized by peers as not “acting black” and being an “Oreo.” In terms of “acting black,” Rachael felt as though she was expected to have more African American friends, behave less “proper” and more disrespectfully in school, and take lower-level mathematics classes with more African American students in them. The “Oreo” epithet referred to peers’ perceptions of Rachael as “black on the outside and white on the inside” in light of her strong academic performance. Rachael alluded to how racial discourses of African Americans not being

educated and not expected to be academically successful gave rise to such peer policing throughout her experiences of success in mathematics.

In high school, Rachael also overheard racial remarks exchanged about African Americans' mathematics ability often coming from students in more advanced mathematics classes. These remarks included "You can't do math because you're black" as well as how African Americans were "stupid" and "only good at sports." It is noteworthy how these racially biased comments and jokes were frequently made in a predominantly black high school setting. Since these remarks came from "smart" students including those in Advanced Placement (AP) calculus, Rachael recalled moments of considering whether these racial remarks held any possible truth to them. This is important considering Rachael and her high school peers' perceptions of mathematics class tracks as racialized spaces. The power of being in AP Calculus and other advanced classes was, therefore, maintained through marginalizing remarks of mathematics ability among African Americans and Latin@s underrepresented in these classes. Moreover, Rachael questioning the validity of these remarks coming from more advanced peers captures how marginalized groups come to be placed in such vulnerable positions to the point of possibly accepting and even internalizing these deficit messages of mathematics ability.

Such power that came with being in more advanced mathematics classes, according to Rachael, was also observed in teachers' differential treatment toward these students. Despite the comfortable learning environment of her high school calculus classroom, Rachael reflected that her teacher "show[ed] a little favoritism" toward students in more advanced mathematics classes like AP calculus. This concerned

Rachael because she had a “friendly” relationship with this teacher that she did not want to jeopardize by not meeting her expectations of being a strong mathematics student. Because Rachael did not see herself “on that level” with the calculus teacher and her favorite students, she avoided seeking extra help by herself even though she was struggling and thus saw herself at a relational disadvantage compared to her AP calculus peers.

A strategy that Rachael adopted in managing this situation with the calculus teacher was bringing an AP calculus student with her to extra help sessions. Rachael leveraged the AP calculus student’s “more personable” relationship with the calculus teacher as a “catalyst” to receive the necessary support while protecting her perceived knowledge of the mathematics. This captures Rachael’s awareness of how mathematics ability comes with interpersonal benefits of establishing stronger relationships with teachers – an important part of her success in mathematics. Rachael, moreover, observed how this is institutionally perpetuated through tracking as teachers may provide students with differential forms of access and support in mathematics learning based on perceived academic ability. This is particularly problematic for students of color like Rachael considering the racialized nature of her high school’s tracked mathematics classes. As a result, Rachael appealed to the power of peers in more advanced classes in order to maintain strong relational ties with her teachers and receive the academic support in mathematics that she needed.

The underrepresentation of African Americans in her mathematics classes was bittersweet for Rachael. On the one hand, it made her feel as though African Americans are not expected to be good at mathematics bringing her to “never want to... overshoot”



and “prepare for the worst, hope for the best.” Rachael attributed such underrepresentation of African Americans and Latin@s in mathematics to why these minorities may lack a sense of belonging and thus feel discouraged from pursuing STEM. To illustrate this, Rachael reflected on feeling judged for her ideas and work as one of the only minorities in her high school precalculus class while also trying to measure up to her younger classmates’ mathematics ability.

At the same time, Rachael felt a sense of pride for being one of the few African Americans present in these mathematics classrooms. Rachael, however, characterized this pride as possibly “playing into the race discrimination” because it brings her to feel as though she is working harder than other African Americans not in the honors mathematics classes with her. Below Rachael reflects on her thoughts when seeing a fellow African American in her classes:

When you see someone else and you’re like ‘Do I need to work as hard as I was working before to like prove myself?’ or like ‘Can I just be myself and take the math class without having to like feel like I have to do well because somebody’s watching me?’ or ‘Should I because I like have to prove that it’s not just her who can do well, it’s like everybody... I have to prove that more than one minority can make it. It’s not like a special case. (Focus Group Discussion)

Here we see Rachael discussing how while seeing another African American in mathematics classes can be uplifting, the racialized expectation that “there’s only supposed to be one” in these spaces also brings her to feel competitive with the other person especially after having been the only African American student for so long. Rachael’s competitiveness, therefore, reflects the impact of African Americans’ underrepresentation as well as racial discourses of mathematics ability bringing her to feel as though she has to not only prove herself as an African American, but also proving that African Americans as a group can be successful in mathematics.

**Navigating intersections of gendered and racial discourses.** At the intersection of gendered and racial discourses as an African American woman, Rachael looked back on her uncertainty of why high school peers distrusted her mathematics ability. She recalled how precalculus classmates, for example, would not approach her with any questions about the mathematics when working in groups. Even in instances when she got the correct answer before others, Rachael's precalculus group members would ask someone else such as the teacher to verify the answer.

And I feel like sometimes people don't question like they don't ask me, maybe its just my mind 'cause I cant say that its for sure because I'm black or I'm a female that they don't want to you know ask me what did you get on this problem or something? But I think that it could be why people don't approach me. (Focus Group Discussion)

When making meaning of this “frustrating” experience of peer distrust, Rachael posited that it could stem from the racial discourse of many African Americans’ “less fortunate or less advantaged” place in society leading to limited opportunities for advancement in mathematics and science. Rachael also considered the possibility that such distrust could come from gendered discourses of women not being good at mathematics or as successful as men in STEM. Boys in Rachael's precalculus group, for example, would say that she was “smart for a girl” after confirming with the teacher or other classmates that her provided answer was correct.

Rachael's expressed uncertainty is important to note as it captures the emotional labor that African American women and other marginalized groups must manage in negotiating discourses of mathematics ability at intersections of gender, race, and other identities. In Rachael's case, she must grapple with the complexity of being unsure if others' judgments of her mathematics ability are based on being African American, a

woman, or both, all the while dealing with the emotional labor of challenging these judgments.

Furthermore, Rachael commented on how African American women in particular are expected to be “better at the athletics or... writing or cultural things” rather than STEM. However, Rachael claimed to have not been frequently subjected to these expectations and was instead encouraged to pursue engineering. She was not necessarily “turned away from mathematics” in transferring out of the engineering program; instead, her transfer decision stemmed from wanting a “more balanced” and “more cultural” college experience that would not have been possible as an engineering major. By transferring out of engineering, Rachael exercised her agency in seeking a different way of challenging herself academically on the pre-medical track in stronger alignment with her views of the college experience. At the same time, it is noteworthy how despite Rachael’s claim that her transfer decision was not influenced by discourses of what African American women should pursue, she described wanting something “more cultural” -- one of her descriptors of things that African American women are expected to be good at instead of STEM. This raises concerns about the university’s presentation of STEM as cultureless that in turn deterred Rachael from pursuing an engineering degree.

### **3.5c Lauren**

Lauren is a first-generation, El Salvadoran-American woman pursuing a computer science major. Her interest in computer science began when her high school accounting teacher took note of her mathematics skills particularly in problem solving and connected her with the school’s computer science teacher. She saw herself as “always good at

math.” Mathematics is something that “came naturally” to her unlike peers whose lack of mathematics ability, according to Lauren, brought them to not like and not be good at the subject. While a shy student across classroom spaces, Lauren’s mathematics ability brought her to feel more comfortable in mathematics classes where it was “okay for [her] to talk.”

Supportive teacher relationships and meaningful mathematics instruction were defining qualities of Lauren’s more favorable mathematics class experiences. Lauren saw herself at a relational advantage over her high school peers because she felt as though mathematics teachers established stronger connections with more advanced students like her. Her struggles in connecting with college mathematics instruction raised concerns for Lauren of having to teach herself and in turn no longer like mathematics.

Algebra 2 Honors was Lauren’s favorite high school mathematics class in light of an “effective method” of instruction and her “friendly relationship” with the teacher. Lauren described how the algebra 2 teacher genuinely cared for his students in and out of the mathematics classroom. During extra help sessions after school, the teacher “wouldn’t just talk about math” but also inquire about how Lauren was doing in her other classes. The teacher also “did not give up on any student” even when they expressed struggles with the class material.

Lauren reflected on working well with algebra 2 classmates who she perceived to be good at mathematics like her as opposed to those who seemed to not care about mathematics as much as she did.

Some of them didn’t want to learn math or didn’t much care much for math so it was like hard with them. But others – they enjoyed math as much as me or as I did so it was easy [with them]... Some of the students didn’t really engage. Like

they didn't just want to be there. Maybe because they didn't like math.  
(Individual Interview)

Here we see how Lauren's perception of mathematics ability as innate informs her discursive separation of fellow students into two groups – namely, those who like and are good at mathematics (including herself) and then those who do not and are not. While positioning herself as someone to whom mathematics “came naturally,” Lauren adopted a compensatory view of others not innately good at mathematics and must make up for their lack of ability.

Precalculus was Lauren's least favorite high school mathematics class. She shared how her precalculus teacher lacked a “consistent method of teaching” characterized by inaccurate assumptions of what students already knew and a “fast pace” without re-visiting earlier concepts. Although Lauren saw herself in the same position as her precalculus classmates as not learning much, she set herself apart as being less affected by her teacher's poor instruction than other “students [for] who... it takes a long time for them to get math.” It is noteworthy how Lauren draws upon her innately strong mathematics ability to distance herself from less mathematically able peers across two mathematics classes with a contrasting nature of instruction.

Although the precalculus teacher seemed “really nice” in her teaching and cultivated a “friendly environment” in the classroom, Lauren described how she was not approachable in the context of seeking extra help with the class material. Both teachers held high expectations of their students, but Lauren discussed how the precalculus teacher in particular seemed to negatively judge students who struggled. With Lauren, the teacher seemed to have “really liked the fact that [she] liked math” yet was firmer with her than other students at lower levels of ability. The precalculus teacher's lack of

approachability brought students to seek each other's help. Lauren saw herself as being "kind of in the middle" by both helping others and receiving help particularly from senior classmates taking the class for the second time. These reflections on student participation being differentially valued raise considerations on how mathematics teachers may perceive certain contributions as more acceptable among advanced students and thus structure varying levels of access to mathematics learning.

In college, Lauren enjoyed her advanced precalculus course with a professor who "wanted everyone to do well." The professor addressed students' questions on the material by presenting different related examples and re-visiting previous lecture content. Lauren reflected on how the professor's "friendly" nature and one-on-one support opportunities may have largely motivated students' office hour participation which she viewed as uncommon across her university courses. Similarly, Lauren described teaching assistant as "deserv[ing] a lot of credit for this course" because of her teaching techniques that encouraged student understanding of the material. The teaching assistant, for example, learned students' names and called on them even if they had not volunteered to answer a question. The comfort that Lauren felt with being randomly called on is an indicator of the supportive learning environment in the classroom that the teaching assistant created that prioritized student understanding and engagement.

It was during college calculus when Lauren reconsidered her pursuits of a computer science major. Lauren mainly attributed her reconsideration to her struggles in learning calculus as a result of her professor's teaching. She described doing "not as good as [she] should be" in calculus because the "teacher isn't teaching" and inaccurately assumes higher levels of understandings from students. Despite Lauren's claim to being

innately good in mathematics, it is interesting to consider how she sees herself struggling in calculus because she “rel[ies] a lot on the teacher” to be successful in mathematics.

Her calculus professor’s teaching brought Lauren to resort to teaching herself the material by reading the textbook and seeking help from other students in her first-year residence hall. This made Lauren feel “overwhelmed with mathematics” as well as fearful that she will always be teaching herself and, in turn, stop liking mathematics. It is noteworthy how even though Lauren previously experienced disagreeable instruction and an unapproachable mathematics teacher in high school, this did not stop her from thinking that she was good at and enjoyed mathematics. Her calculus experience, however, brought Lauren to feel as though she would face similar struggles throughout the remainder of her college mathematics coursework to the point of no longer liking and feeling like she was bad at mathematics. The differences in instruction and teacher-student relationships between high school and college, thus, seem to have shifted Lauren’s conceptualizations of learning mathematics and her mathematics ability.

Her growing frustrations with not being as good at mathematics in college calculus brought her to “slack” and not participate as much in the classroom like she did in high school. Lauren’s idea of being naturally good at mathematics coupled with how teaching herself did not result in better grades led her to question continuing the computer science major.

I feel like its frustrating that I don’t know it as good as I should know it ‘cause I feel like I’m overconfident in math that right now, since I don’t know it, it’s kind of making me less interested – not less interested in math, but in like trying to teach myself. (Individual Interview)

It is important to note how Lauren clarified that her frustration is leading her to become less interested not in mathematics, but the process of teaching herself – a common mode of mathematics course preparation that Lauren observed among her college peers. This distinction is important because it captures how Lauren does not disassociate with

mathematics, but rather the idea of learning mathematics without receiving support from teachers – a defining quality of her favorite high school mathematics classes. Thus, Lauren’s reconsiderations do not arise from seeing herself as mathematically incapable, but instead from exercising agency in avoiding situations like teaching herself that jeopardize her confidence and enjoyment of mathematics.

**Gendered discourses of mathematics ability.** Lauren reflected on women’s underrepresentation in STEM based on observations of often being the only or one of the only girls in her college classes. Despite the discourse of Latin@s and other racial minorities less represented in STEM fields, Lauren saw the student enrollment in her computer science classes as racially diverse but being less balanced between boys and girls compared to high school.

The classes are definitely diverse. Like I feel it’s more gender like I know in my computer science class, I’m the only girl in my recitation. So I feel like I feel it’s more of a gender that’s different in the classes. (Focus Group Discussion)

This noted contrast between the boy-girl representation in Lauren’s high school and college STEM classes captures how gender was more salient in her mathematics experience at the university. Gender, however, was less significant to Lauren as a high school mathematics student mainly because she saw the mathematics department as “really split up” between men and women serving as teachers. Lauren asserted that this balanced representation lessened the significance of the “gender thing” – namely, the discourse of women being less represented and mathematically capable than men. The presence of women as mathematics teachers in her high school, according to Lauren, served as a way of showing students, particularly the boys, that “a female can do it [mathematics] too.”



**Racial discourses of mathematics ability.** Lauren did not see fellow Latin@s trying hard to advance academically or professionally. She drew on “really disappointing” observations that most of her Latin@ high school friends were complacent with receiving a high school diploma and not seeking any higher forms of education.

I’m from out of state like I came out of state just to come to college. I could’ve stayed in-state, but I wanted to try something new like my friends, like it doesn’t seem like they want to do anything but stay a high school graduate and that’s it. I don’t really see them trying. I’m not talking about Latinos as a whole or saying like they are not trying, but in my experience, I just feel like they are not. (Focus Group Discussion)

Here we saw Lauren positioning herself as trying harder academically than her Latin@ high school peers by moving out of state to go to college. Lauren alluded to similar complacency among her Latin@ family members particularly her cousins who did not pursue anything beyond a high school education.

In relation to mathematics, Lauren raised the discourse of Latin@s being underrepresented and not successful in STEM fields. She discussed how seeing other Latin@s pursuing STEM degrees and careers may motivate Latin@s to do the same and thus increase their representation across these areas. As a first-generation college student in STEM, Lauren saw herself as this “role model” to family members, particularly younger generations, so they can think to themselves, “Oh, she did it so we can do it too.” Lauren, therefore, views her academic pursuits at the university as allowing her family members and other Latin@s to look past racial discourses in STEM, be more likely to pursue it, and thus soon become “a majority in these fields.”

**Navigating intersections of gendered and racial discourses.** At the intersections of gender and race, Lauren commented on Latin@ women being underrepresented across STEM fields. She, for example, reflected on reviewing statistics

introduced in her women's leadership class where she noted that Latin@ women were the most underrepresented group in STEM. When reacting to these statistics, Lauren attributed them to Latin@ women lacking motivation because they receive minimal encouragement and mentorship from others to pursue STEM.

I think that maybe they [Latin@ women] probably weren't mentored enough. So they feel like they can't do it or they're not good enough at it... 'Cause I know a lot of people say they don't like math and it kinda bothers me when people say that they don't like math. (Individual Interview)

This reflection captures how despite Lauren's views of mathematics ability as innate, she rationalizes Latin@ women's underrepresentation in terms of not receiving adequate forms of outside support. Thus, Lauren seems to depart here from the discourse of Latin@ women as being inherently unmotivated or incapable of success in STEM and instead asserts that they receive minimal support allowing them to feel that they can do it.

Lauren also discussed her encounters with discourses of Latin@ women as young mothers and wives rather than college students. She looked back on how boys in high school would often make remarks to girls such as "You should be at home taking care of the kids" when they saw them in class or thinking about applying to colleges.

In my high school, like all of the Hispanics like my friends they would say things like even to us – their friends – like 'Oh you shouldn't be going to college or trying to be good at math' cause they just think that it's not normal for a girl to be good at math especially a Latina girl. So I mean I have experienced that like girls aren't good at math, Latinas aren't good at math. (Focus Group Discussion)

Lauren went on to explain how these peer comments seemed to originate from parents and older generations' gendered division of labor in the Latin@ household – namely, "the men worked and the women stayed at home." It is also noteworthy how, in this reflection, Lauren saw these peer comments as reflections of others' expectations that Latin@ girls are not good at mathematics.

When asked about the extent to which hearing these high school peers' remarks impacted her academic pursuits, Lauren shared how it had not because her family has encouraged her to "break that tradition" and pursue a college degree. She distinguished this encouragement with many other Latin@ family situations that perpetuate traditional cultural expectations of women as mothers and wives. In alignment with her views on the importance of supporting Latin@ women to feel as though they can do STEM, Lauren commented on how other Latin@ girls may not consider mathematics as a possibility because their families have not "taught [them] that they can do math" or their "parents might say like you can't do math." Family support, therefore, plays an important role in how Lauren negotiates discourses on Latin@ women with her STEM pursuits at the university.

### **3.5d Tracey**

Tracey is a first-generation, Cuban American woman pursuing a double major in mathematics and theater arts at the university to become a high school mathematics teacher. She saw mathematics as "what [she] was good at" as well as what made her confident in terms of feeling "intellectually smart." Her passion for mathematics was largely influenced by her high school education that began early when she was recommended by her middle school teachers and guidance counselor for an accelerated algebra course in eighth grade. Tracey's views of her mathematics ability as innate were challenged as a high school sophomore when she saw mathematics success as a matter of hard work and "want[ing] to learn." Strong relationships with teachers and classmates as well as meaningfully connecting with the mathematics were characteristics of Tracey's positive high school and college mathematics experiences. This included teachers who

believed in her mathematics ability, instruction that explored the connectedness and applications of the mathematics, and familiar peers to form study groups.

Although Tracey chose algebra as her least favorite high school mathematics class, this was based more on the challenging academic transition into high school rather than aspects specific to her teacher and the classroom environment. She characterized her teacher, Ms. Chester, as “terrifying” and “scary” in the classroom such that students were “so nervous about asking her questions.” However, Tracey saw this as part of Ms. Chester’s “very big” teaching performance and recognized that she was really “sweet and fun” despite her “rough and tough” classroom persona. It is important to note here how Tracey and her algebra classmates looked past Ms. Chester’s authoritarian teaching approach and respected her because she was supportive and believed in her students. For example, Tracey reflected on how Ms. Chester communicated such belief in her students’ ability and equal opportunity to succeed during the first day of class.

She was... very opportunistic that we would rise. And she told us the first day, ‘I’ve had many eighth grade students take this class. I’ve had my freshmen take this class. They can do it; you can do it. And you guys will do it. And I believe in you ‘cause everybody has a chance. (Individual Interview)

Ms. Chester’s high expectations for her students’ academic success and belief in their ability resonate with the characteristics of culturally responsive teaching in urban classrooms (Gay, 2010; Ladson-Billings, 1995).

AP Calculus, for example, was Tracey’s most favorite high school mathematics class. The teacher, Mr. Sosa, was accessible for extra help during and after school hours as well as had a “great way [for] explaining the material” that allowed her to make connections between calculus and earlier mathematics classes. Mr. Sosa’s positive perceptions of his students’ mathematics ability as well as his teaching practices for

building conceptual understanding depart from the well-documented deficit teacher beliefs and rote, disconnected instruction across urban mathematics classrooms (Ladson-Billings, 1997; Lubienski, 2002). Tracey kept in contact with Mr. Sosa after graduation as it was “thanks to him that [she] enjoy[s] math.”

Another favorable aspect of Tracey’s algebra AP calculus experiences was taking the class with high school peers who she previously knew from growing up in their “small, well-knit town.” Tracey found taking algebra with other eighth graders to be helpful because she could seek their support with any of the material outside of the class. The familiarity of her calculus classmates who Tracey saw as her “friends” facilitated the formation of informal peer study groups outside of class. The study group meetings were comfortable, supportive spaces for peer collaboration that Tracey characterized as “going to a friend’s house to hang out, but instead of hanging out, we were deriving and stuff.”

Her preference of working with others on mathematics continued into Tracey’s college years. In first-semester calculus, Tracey made friends and studied with classmates also sitting toward the front of the lecture hall. She recalled becoming friends with a fellow girl classmate and how their relationship progressed from “small talk” to “girl talk” and finally to a friendship of telling each other, “Hey, come over. Let’s do calculus together.” Additionally, Tracey reflected on studying for second-semester calculus with a peer from the university’s engineering program who was also a former AP calculus classmate in high school. Tracey commented on how it was helpful studying with her since the engineering course section was further along in the curriculum and the peer was someone familiar in the context of doing mathematics.

Much like her reflections on Ms. Chester and Mr. Sosa, Tracey remarked on her appreciation of having personable college mathematics instructors who connected with their students. She described how her first-semester calculus graduate teaching assistant, Vince, was the “funniest man ever” who the students regularly approached during weekly problem-solving workshops with questions. In addition, Tracey appreciated Vince’s student-centered facilitation of the calculus workshops such as soliciting questions from students as well as approaching problem-solving groups to offer guidance and support.

During her first semester, Tracey made sure that she sat toward the front of the college calculus lecture because her professor only “taught to those who wanted to learn.” She recalled one of the professor’s introductory remarks for the course on his perception of students who are learning and those who are not learning in the college classroom. By sitting at the front of the lecture hall, Tracey positioned herself as a student who “wanted to learn” or at least be perceived in this way by other including the professor.

Prior to Tracey’s first semester at the university, she participated in a five-week summer intensive program for financially disadvantaged incoming students that served as a “heads up” for their upcoming college years. This program included a calculus workshop that Tracey found as a refresher of AP calculus and prepared her to be successful with first-semester calculus. Tracey, however, found herself questioning if she wanted to continue pursuing a mathematics major after her first exam in second-semester calculus. She described how her efforts such as attending lectures, contacting instructors for extra help, and completing homework assignments did not translate into the exam grades that she expected in return. In contrast to her early appreciation of conceptually understanding calculus in high school, Tracey adopted a more rote, procedural approach

of “just doing practice problems... [and] doing it over and over” to prepare for college calculus. This shift in Tracey’s perspective on doing mathematics raises concerns about the instruction and values of mathematics learning in college mathematics as well as the extent to which incoming students like Tracey are prepared to successfully engage with it.

**Gendered discourses of mathematics ability.** Tracey expressed mindfulness of how others perceived her in terms of looking and sounding “smart” as a Latin@ girl in mathematics. She, moreover, was critically conscious of how the gendered and racial makeup of her high school and university contexts shaped these judgments of her mathematics ability.

In high school, Tracey encountered more gendered than racialized judgments of her ability as a Latin@ girl because the student population was predominantly Latin@ like her. While describing her AP calculus class as “really, really smart” with most students designated among the high school’s top 25 graduating seniors, Tracey took note of girls’ underrepresentation as being one of only four girls enrolled in the class. It was particularly in this class where discourses of boys being better at mathematics and smarter than girls gave rise to “gender battles.”

I felt I had to prove to them that I’m a girl but I’m actually smarter than you guys so you guys have to back off. And it got some of the kids mad because I guess they were getting beaten by a girl at some points... It was just aggravating to walk into class and know that ‘Alright, it’s a competition.’ I have to pay attention because I don’t wanna lose again to these guys because they think they are better.  
(Focus Group Discussion)

This reflection captures the gendered competitiveness of the AP calculus classroom that brought Tracey to feel as though she had to constantly prove being smarter than boys in class. Mr. Sosa contributed to this gendered peer competition by pitting students against

each other for top spots in the class particularly between boys and girls. For example, she recalled moments when Mr. Sosa would joke around that she did not understand the material “[be]cause she was a girl.” Her ranking as second in the AP calculus class not only offered Tracey validation that she was “up there in calculus,” but also served as a way of “proving to the guys” that girls were also smart.

Looking across Tracey’s reflections on the gendered dynamics from the AP calculus class, it is noteworthy how Mr. Sosa as the teacher, although jokingly, engaged the gendered discourses of girls not being good at mathematics and less smart than boys. Rather than discouraging Tracey and other girls from doing well in the class, Mr. Sosa’s joking remarks and encouraged competition motivated the girls to “stick together” in bringing the boys to feel “threatened by [their] girly greatness.” Such “gender battle” dynamics capture the relational space that Mr. Sosa established in the class that allowed what could be marginalizing discourses of girls’ mathematics ability to be challenged and engaged constructively among the students.

**Racial discourses of mathematics ability.** It was during her first year at the university when Tracey experienced a more heightened awareness of facing racial judgments of her mathematics ability. With a smaller representation of Latin@s at the predominantly white university compared to her high school, Tracey felt as though Latin@s were lumped together as one homogeneous racial group as opposed to the appreciation of Latin@s’ cultural diversity throughout high school. This lack of acknowledged within-group variation in college, according to Tracey, contributed to her being subjected to racial judgments premised on discourses of Latin@s as a group not being good at mathematics.



But we were all Latinas, we were all Latinos [in high school]... so there wasn't really a discouragement there on race and mathematics. When I came here [to the university], it was really weird when people would ask me, 'What major are you?' and I'd say, 'Oh, I'm thinking of math'. 'Oh! Math?! Really? Wow! I wouldn't have expected that. (Individual Interview)

This reflection is noteworthy as it captures Tracey's critical awareness of her high school and university as institutional spaces racialized in different ways shaped the judgments of mathematics ability that she encountered as well as her consciousness of them. In particular, Tracey was more conscious of her Latin@ identity at the university through others' reactions of disbelief and surprise about her pursuits of a mathematics major.

Looking back on her high school experience, Tracey commented on how mutually identifying with mathematics teachers in terms of gender and race can be beneficial in managing gendered and racialized status of mathematics ability in the classroom. To illustrate this dynamic, Tracey discussed how Latin@ teachers like Mr. Sosa would often "stick up" for her during moments when classmates criticized her "basic small questions" in mathematics. This racial teacher-student connection, according to Tracey, provided him with cultural insights and shared understandings of experience that made Mr. Sosa's interventions in challenging peer judgments of her and other Latin@ students' mathematics ability more meaningful. Tracey's reflection on such teacher-student connection highlights the importance of teachers being critically aware of how racial as well as gendered discourses of mathematics ability and how to challenge them in establishing positive learning experiences for all students.

**Navigating intersections of gendered and racial discourses.** At the intersections of gender and race, Tracey saw herself as the "perfect example of why the Latinas don't make it in mathematics." She described how Latin@ women, in particular,

must negotiate their families' gendered cultural expectations of early marriage and motherhood with academic responsibilities of getting a college degree especially in mathematics and other demanding STEM areas. Tracey shared the following reflection of messages that she received from older family members including her grandmother since starting college:

My grandmother especially is like 'You're going to college? Tracey, you're eighteen. You need to get married. You need to start a life. I need great grandbabies. You need to step it up. You're slacking.' Like I'm slacking because I am in college? And it was just to deal with that pressure the entire time of my goal in life is to be a wife and a mom, not to further my education. I'm supposed to provide for my family, my husband, and my kids when I'm only eighteen. (Individual Interview)

Such family expectations of motherhood and marriage subsequently shaped Tracey's views of Latin@ women as mothers and wives who "breed and... tend to [their] husband." In addition to her family, Tracey encountered such cultural views of Latin@ women in her hometown and high school. Teenage pregnancy, for example, was a "casual thing" among young Latin@ girls in her hometown. Tracey also heard comments from boy classmates in high school mathematics classes such as "Go back to the kitchen" and "You need to be married."

At the same time, Tracey acknowledged that these cultural views on the roles of Latin@ women were "very old-fashioned" that often reflected older generations' gendered division of household labor in their home countries. She commented on how these more traditional expectations of Latin@ women found their way into her home through her grandparents' recent immigration from Cuba, giving rise to gendered discourses of Latin@ women that conflicted with her higher education pursuits in the United States. The concept of *familismo* (Marin & Marin, 1991; Suarez-Orozco &

Suarez-Orozco, 1995), or strong feelings of loyalty and responsibility for the Latin@ family unit, offers an analytical lens to better understand the conflict that Tracey experienced between meeting her family's expectations and pursuing a college degree in mathematics.

Tracey discussed the important support that she receives from fellow Latin@ women including high school peers and her mother who can relate to her experiences in negotiating academics and family expectations. She commented on how her Latin@ girlfriends were successful in AP calculus because they "stuck together" in challenging the discourse of Latin@ women's underrepresentation in STEM. Such support continued in college as all of Tracey's Latin@ girlfriends who were also first-generation college students attended the same university. They supported each other in managing their college academics alongside family expectations of maintaining the cultural status quo of Latin@ women as young mothers and wives.

In addition, Tracey saw her mother as a frame of reference of what can happen to a college-bound Latin@ woman when "culture catches up" to her in the United States. In particular, her mother was unable to complete a college degree in mathematics education after she was pregnant with Tracey and needed to start a job for financially supporting the family.

I saw what happened to my mom. She pursued a math career, culture caught up with her, and now she's in that situation. If I go down that path, I am not going to move forward... I don't wanna have a job that I hate. I don't want to go to work every day saying 'I have to stay here from this to this hour and do this and this because I have a mouth to feed and I have people to put a roof over [my family members' heads]. (Individual Interview)

Here we see how Tracey uses her mother's story as motivation to "carry on [her] mom's legacy" as well as challenge discourses of Latin@ women as young mothers without a

college education. Tracey's mother also expressed unconditional support for her regardless of whether or not "culture catches up" to her while in college. Although such support perpetuates discourses about Latin@ women, it also serves as another example of familismo with Tracey's mother remaining loyal and responsible for her daughter's well being no matter the circumstances. This form of support is noteworthy because it comes from a fellow Latin@ woman, although from a different generation, who understands and has lived through the struggles of pursuing a college education in mathematics in the United States.

Such support from fellow Latin@ women brought Tracey to see her pursuits as a mathematics major and future mathematics teacher as a call to action – namely, giving back to her hometown so she can inspire Latin@ girls to disrupt racial stereotypes and gendered norms in mathematics. This aligns with her view on how students mutually identifying with teachers in terms of gender and race allows for shared understandings to support them in broadening their perceived opportunities in mathematics.

### **3.5e Cross-Case Analysis of Mathematics Counter-Stories**

Looking across these counter-stories, we see the variation in how the four women of color invoked gendered and racial discourses of mathematics ability to make meaning of their experiences. The following cross-case analysis examines how the women of color were subjected to these discourses institutionally and interpersonally while highlighting strategies in navigating them at intersections of gender and race. In doing so, four emergent themes across the women of color's counter-stories are discussed. These themes include (i) gendered and racialized negotiations of the discourse on innate mathematics ability, (ii) institutional spaces (including mathematics classrooms) shaping

discourses that the women of color encountered, (iii) the African American women's emotional labor of managing the intersectional ambiguity of microaggressions in mathematics, and (iv) the Latin@ women's negotiations of the discourse on becoming young mothers and wives rather than pursuing higher education.

**Innateness of mathematics ability as gendered and racialized.** The four women, in different ways, raised the discourse of mathematics ability as innate and unrelated to gender or race. Kelly and Lauren, for example, supported such innateness in seeing themselves as good at mathematics compared to others struggling in their classes. Lauren saw her innate mathematics ability as providing her with an advantage in building stronger relationships with teachers, feeling comfortable participating in classes, and working well with peers at similar levels of ability. Even though Kelly claimed to remain humble about her academics, both she and Lauren regularly compared and separated themselves from peers that they perceived to not be good at mathematics like them. This discursively produces a binary of good/not good at mathematics to position individuals along a hierarchy of mathematics ability.

These reflections, furthermore, capture how Kelly and Lauren internalized the discourse of innate mathematics ability. On the one hand, this internalized discourse served them in making meaning of their accomplishments in mathematics as reflections being innately good at mathematics. Kelly, for example, interpreted her strong performance in college precalculus, a course that others found to be “really hard,” as being explained by the fact that “either [she was] good at math or... they [her peers] are bad at math.” Here we see that in positioning herself as being innately able to do well in mathematics, Kelly invokes the good/not good at mathematics binary by distinguishing

herself from college precalculus peers who struggled probably because they were not innately good like her.

At the same time, the internalized discourse of innateness also disadvantaged them in moments when Kelly and Lauren struggled with mathematics. When Lauren looked back on “not doing as good as [she] should be” in college calculus, she attributed her struggles to her professor’s poor teaching rather than anything related to mathematics ability. The importance of teaching in Lauren’s mathematics success, however, runs counter to innateness of ability so the discourse was not able to serve her under this circumstance. With the discourse of innate ability internalized, Lauren described calculus as a frustrating and scary experience because “[she didn’t] want to ever feel like [she’ll] be bad at math.” This brought Lauren to reconsider computer science as a major while asserting that this decision did not stem from seeing herself incapable or from being “less interested in math, but in like trying to teach [herself].”

In contrast, Rachael and Tracey challenged the innateness discourse through discussions of how access and opportunities in mathematics are both gendered and racialized. For example, high school peers’ discrediting of Rachael’s acceptance into an Ivy League school as being based on affirmative action rather than academic merit brought her to question, “Why does [my] intelligence have to be based off of how well I do in my math class?” She further problematized the innateness of ability considering how mathematics classes in her high school were racialized spaces such that African American and Latin@ students had limited access to high-quality instruction and supportive teacher relationships. Tracey similarly highlighted the underrepresentation of girls in her AP calculus class and how this resulted in “gender battles” where she and

fellow girl classmates worked collectively to disprove the discourse of men being innately better at mathematics than women.

Rachael and Tracey's reflections, therefore, point to the systemic issues of underachievement and underrepresentation of racial minorities and women in mathematics. When innateness of mathematics ability – a discourse framed by colorblind and gender-blind ideologies – is coupled with these systemic issues, racial minorities' and women's underachievement and underrepresentation come to be explained as these historically marginalized groups being inherently deficient of potential for success academically and mathematically (Battey & Leyva, under review, 2015b; Martin, 2009, 2013; Mendick, 2006). Thus, a racialized and gendered hierarchy of mathematics ability is produced. Innateness of mathematics ability serves as a colorblind and gender-blind way of discussing this racialized and gendered hierarchy. This was evidenced in the academic discrediting of Rachael's college acceptance under affirmative action as well as Tracey feeling like she and other underrepresented girls had to prove being smart in AP calculus. Furthermore, this gendered and racialized hierarchy also brings fellow members of marginalized groups to position each other as more or less of an African American, Latin@, or woman based on perceived mathematics ability (Mendick, 2006; Stinson, 2008). This was observed when Kelly and Lauren distinguished themselves from other African Americans and Latin@s respectively who they deemed less mathematically able as well as the women of color's encountered peer policing of "acting white" and being "smart for a girl."

**Institutional spaces shaping gendered and racialized discourses.** The ways in which schools, classrooms, and other institutional spaces were gendered and racialized

shaped the discourses that the women of color encountered as mathematics students (Moore, 2008; Stinson, 2008). Lauren, for instance, described feeling more conscious of women's underrepresentation in STEM at the university as one of the only girls in her computer science classes. The "gender thing" was not as significant in high school considering the equal representation of women and men as mathematics teachers. Tracey felt her mathematics ability subject to scrutiny in relation to her gender identity at her predominantly Latin@ high school, but judged more so racially at the predominantly white university. I caution that being surrounded by teachers and peers with shared gender and racial identities is not a panacea to make marginalized individuals' mathematics experiences completely easier. Rachael, for example, attended a predominantly African American high school and still encountered comments about not "acting black" enough and being an "Oreo" due to her strong mathematics performance. These reflections capture how consciousness of gender and race varies across contexts and thus give rise to different positionings of oneself and others along the hierarchy of mathematics ability.

It is particularly important to consider the extent to which these gendered and racial discourses shaped the nature of instruction and quality of teacher-student relationships across the four women of color's high school and college mathematics classrooms (Battey, 2013b; Battey et al., 2016). In alignment with culturally responsive teaching, the women of color described how their mathematics success in high school was largely attributed to establishing positive, supportive relationships with teachers who held high academic expectations of them (Gay, 2010; Ladson-Billings, 1995). However, three of the four women discussed reconsidering their pursuits of math-intensive majors



after their first semester at the university. While Rachael wanted a college experience that was “more cultural” than what STEM coursework offered to engineering majors, Lauren and Tracey raised concerns about the fast pace of college mathematics instruction and seeing their preparations not translate into better grades. These reflections put into question the intended student audience for the university’s mathematics instruction and how this subsequently impacted the women of color’s opportunities to connect with the content and receive necessary support to be successful. The women of color’s shared stories of other students feeling disconnected and rejected in college STEM classrooms, moreover, capture their critical awareness of how these relational dimensions of instruction or lack thereof perpetuate gendered and racial discourses of mathematics ability. This included Kelly’s reflection on her African American friend thinking about transferring to a historically black college or university and Rachael’s story of the trans\* student whose mathematics ability was no longer questioned by a professor after his gender transition.

### **Emotional labor of managing intersectional ambiguity among African**

**American women.** The intersectionality across the four women of color’s mathematics experiences is evidenced in the variation of strategies that they employed to overcome the marginalization of gendered and racial discourses (Bowleg, 2008). It is noteworthy how Kelly and Rachael made meaning of their experiences in relation to gendered discourses applicable to all women and racial discourses applicable to all African Americans. Barely any intersectional discourses specific to African American women were supported or challenged across their counter-stories. Despite not raising any intersectional discourses, the intersectional issue for Kelly and Rachael was the emotional labor of

being uncertain whether microaggressions of their mathematics ability came from gendered or racial discourses. Kelly and Lauren, as African American women, see themselves at intersections of gendered and racial discourses in mathematics and thus as having to manage the intersectional ambiguity of microaggressions of ability in their experiences. Both women, for example, were uncertain if others distrusted their mathematical contributions, did not approach them for help, and discredited their academic achievements on the count of being women, African American, or both in different situations.

Kelly and Rachael, as a result, selectively shared their good grades in mathematics and other accomplishments to protect their identities from such microaggressions. This strategy of purposeful silencing, however, is problematic as it maintains the gendered and racialized status quo of who is considered mathematically able. Despite this common strategy, Kelly and Rachael differed on the extent to which they challenged these discourses in making meaning of their mathematics success as a gendered and racialized experience. Although she claimed not to do so, Kelly actively compared her academic performance to that of others and interpreted her higher grades in mathematics as validation that she must be innately good at mathematics. It is interesting to note Kelly's acceptance of the innateness discourse inscribing colorblindness and gender-blindness while she also challenging notions of men's lack of humility in mathematics and all African Americans wanting to be cool rather than smart. Rachael, on the other hand, was more vocal in her skepticism of needing to prove her mathematics ability across classroom spaces where she felt underrepresented and at a relational disadvantage with teachers. Even in spite of her expressed frustration, Rachael discussed

engaging in strategies like not “overshoot[ing]” in mathematics classes and bringing peers deemed more mathematically able to receive better support from her teachers.

**Navigating intersectional discourses of young mothers and wives among Latin@ women.** Unlike the African American women, Lauren and Tracey drew on the intersectional discourse specific to Latin@ women (namely, becoming young mothers and wives) in addition to gendered and racial discourses that Kelly and Rachael also raised. Lauren and Tracey both challenged this discourse, but their strategies in doing so differed. Lauren, for example, positioned herself as an exception to the discourse that she saw shaping the “really disappointing” complacency academically and professionally among her family members and high school peers. She discussed taking steps in her academic development that other Latin@ girls in her hometown did not such as being one of the few in her graduating class and the first in her family to pursue a college degree. Whereas Tracey did not position herself as an exception, but rather acknowledged how “girl things” among Latin@s such as being expected to have boyfriends and celebrating her quinceañera often got in her way of being successful in mathematics. She discussed the importance of building networks with fellow Latin@s women interested in mathematics to collectively support one other with negotiating these cultural expectations and their STEM pursuits.

Despite these differences, Lauren and Tracey described how they saw their success in STEM as a call to action in broadening opportunities in mathematics for Latin@s and fellow Latin@ women in particular. Lauren, for example, saw herself serving as a role model to younger generations, including her cousins, as a Latin@ women who did not fall victim to the discourses of becoming a mother or wife rather than

a college graduate. Tracey similarly viewed her future role as a high school mathematics teacher as an opportunity for Latin@ girls to see themselves as capable of pursuing mathematics. The Latin@ women's familismo (Marin & Marin, 1991; Suarez-Orozco & Suarez-Orozco, 1995), or sense of loyalty and responsibility to the Latin@ family unit, played a critical role in their motivations to excel in high school mathematics as well as their negotiations of STEM higher education with family expectations. Lauren discussed how her family stood apart from other Latin@ families who push their daughters to follow tradition and become young mothers or wives. Instead, her family provided her with the encouragement that Lauren claims Latin@ girls should receive to feel as though they can do mathematics and have a future in STEM. Tracey characterized her mother as a frame of reference of "culture catch[ing] up" to a Latin@ woman which motivated her to pick up where her mother left off in becoming a mathematics teacher. By "carrying on [her] mom's legacy," Tracey sees herself giving back to her hometown community as a mathematics teacher who will encourage Latin@ girls to "beat the stereotypes of race... and social norms of gender" in mathematics.

### **3.6 Discussion and Implications**

This study presented four cases of undergraduate women of color's mathematics experiences with analytical attention to how they navigated gendered and racial discourses of mathematics ability at institutional, interpersonal, and ideological levels. The intersectional analysis of the women of color's counter-stories in mathematics details the complexity of how these African American and Latin@ women made meanings of their experiences and negotiated their mathematics success at intersections of gender and race (Esmonde, et al., 2009; Martin 2009). More specifically, examining these two

race/gender intersections across the four women of color's experiences allows us to learn from the variation in their individual strategies for managing discourses of ability and underrepresentation and how they mapped onto empowerment, resilience, and success (Bowleg, 2008; Espinosa, 2011).

By exploring gender as a social construct, this work departs from sex-based, binary analyses comparing women and men's differences in mathematics and thus allowed for capturing within-group variation of experience, in this case, among women (Esmonde, 2011; Mendick, 2006). The placement of intersections of gender and race at the analytical forefront advances critical work in mathematics education that, by and large, has left intersectionality of mathematics experience, especially among women of color, implicit in their analyses (Leyva, accepted). To do this, the study's post-structural analysis documents the four women of color's different ways of doing both gender and race in their experiences of being at intersections of gendered and racial discourses in mathematics. Although intersections of gender and race were the main focus, we can see how the four women of color's experiences were shaped by other identities including class (e.g., attending urban high schools) as well as generational status and immigration particularly among the Latin@ women. This calls for future research that considers other intersections of identity to generate deeper understandings of women of color and other marginalized groups' mathematics experiences.

The high school-to-college transition was a challenging experience that came with pedagogical and relational shifts in mathematics teaching that resulted in the women of color's reconsiderations of math-intensive STEM degrees. This raises considerations on how women of color and other marginalized groups are supported across the P-16 school

pipeline so they can successfully meet expectations and norms of undergraduate mathematics success especially at predominantly white institutions. The women of color's reflections captured the mathematics classroom as a figured world in which teachers and peers constantly position students as more or less mathematically able (Boaler & Greeno, 2000; Holland et al., 1998). Gendered and racial discourses of mathematics ability, in particular, shape the meanings of being successful in these classroom spaces and, thus, the differential opportunities for being perceived in this way (Barnes, 2000; McGee & Martin, 2011; Shah, under review). Such gendering and racializing of the college mathematics classroom experience is evidenced in the women of color's discussions of limited connections with instruction, poor relationships with instructors, and feelings of underrepresentation compared to their high school years (Battey, 2013b; Battey et al., 2016; Varley Gutiérrez et al., 2011).

As a result, the women of color reflected on dealing with the labor of managing others' perceptions of their ability through strategies such as sitting in the front to appear serious about learning, silencing their achievements to avoid presenting themselves as better than others, and accompanying more advanced peers to receive higher-quality support from their teachers. This labor is emotionally exhausting for African American and Latin@ women, in particular, who find themselves at intersections of gendered and racial discourses and often do not know which discourses are being used to judge them across these mathematics classroom spaces. Thus, P-16 mathematics teachers have an important role in being aware of these deficit perspectives and supporting marginalized student populations, including women of color, in successfully navigating them to broaden their opportunities for success in mathematics. This is especially important at

the undergraduate level with entry-level mathematics courses like calculus documented as a critical filter that results in the attrition of STEM-intending majors as we saw in the women of color's academic reconsiderations by first- or second-semester calculus (Chen, 2013; Rasmussen et al., 2014). Furthermore, a mathematics degree is often a prerequisite in being certified as a K-12 mathematics teacher. Increasing retention rates in undergraduate mathematics, thus, would further diversify the P-12 teaching force and connect underrepresented students with individuals like them who can relate to their experiences and support them in challenging these deficit discourses. This is important as the women of color in the study discussed the influence of connecting and building networks with other African American and Latin@ women, but they were mostly family members and peers as opposed to successful women of color in mathematics and mathematics education.

Findings from this study corroborate those from extant work in urban mathematics education on the importance of peer networks in students of color's mathematics success (Oppland-Cordell, 2014; Treisman, 1992; Walker, 2006). The women of color had established peer networks in their home communities that served as resources for their early success in mathematics. Ties to these peer networks were severed for many of the women of color once they started their first year at the university and were left with the task of re-building such networks on their own to be successful in undergraduate mathematics. This not only challenges Treisman's (1992) claim that the ability to form such networks is inherently missing from students of color, but more importantly, communicates the important responsibility that STEM support programs especially at predominantly white institutions have in students of color's development of

peer networks. The four women of color's experiences capture the need that STEM support programs can better address in supporting marginalized groups with managing gendered and racialized discourses as well as navigating institutional spaces in undergraduate STEM education (Brown, 2002; Patton, McEwen, Rendón, & Howard-Hamilton, 2007).

A limitation of this study is the lack of observations of the women of color across undergraduate mathematics classroom and STEM support program spaces to complement their reflections of gendered and racialized engagement with content, peers, and instructors at the university. Thus, there is analytical space for future research that examines the instructional and relational spaces of undergraduate STEM education including mathematics classrooms to document how opportunities for mathematics learning are promoted or hindered for marginalized populations. Such investigative insights can inform the training of undergraduate mathematics educators to maintain the continuity of academic and social support that the women of color reported having in their K-12 education and then became limited at the university level.



**Chapter 4: “Representing” in Engineering: A Phenomenology of Mathematics  
Success among Undergraduate Latin@ Engineering Students at a Predominantly  
White University**

**Abstract**

Latin@s demonstrated an increase of nearly 75% in engineering degree completion over the last 15 years (NSF, 2015). However, Latin@s remain largely underrepresented across STEM disciplines with scholars calling for in-depth qualitative analyses of their undergraduate education experiences to improve retention (Cole & Espinoza, 2008; Crisp et al., 2009). With undergraduate mathematics including calculus as a gatekeeper into advanced STEM courses, it is critical to examine undergraduate mathematics as a social experience for underrepresented populations including Latin@s (Chen, 2013; Rasmussen et al., 2014). This chapter presents findings from a phenomenological study on mathematics success as a gendered and racialized experience among two Latin@ men pursuing engineering majors at a large, predominantly white four-year university. A cross-case analysis examines how notions of *apoyo* (Auerbach, 2006), *consejos* (Delgado-Gaitan, 1994), and *familismo* (Marin & Marin, 1991; Suarez-Orozco & Suarez-Orozco, 1995) shaped the variation between the two men’s experiences in navigating undergraduate mathematics as a white, masculinized institutional space as well as negotiating discourses of mathematics success with their identities as Latin@ men. Implications for undergraduate mathematics education and STEM support programs are raised to increase Latin@s and other marginalized groups’ access to academic and social support for mathematics success in and out of classrooms.

**Keywords:** gender, intersectionality, Latin@s, race, teaching

#### 4.1 Introduction

Latin@s, the largest ethnic minority in the United States, have an estimated population of over 53 million in 2012 projected to keep growing and constitute approximately 30% of the total American nation by 2050 (U.S. Census Bureau, 2013). Despite this population growth, it has only produced a small increase in Latin@ college enrollment (Chapa & De La Rosa, 2006, Cole & Espinoza, 2008). In a recent survey of American first-year students in four-year postsecondary institutions, more than 40% of Latin@s expressed interest in pursuing a STEM major upon college entry – a rate comparable to their white counterparts (NSF, 2013). However, Latin@s earned less than 10% of engineering and mathematics degrees in 2012 while close to 70% were awarded to whites (NSF, 2013). Many Latin@s' strong initial intention of majoring in STEM, thus, does not translate into equally high rates of STEM degree completion.

In-depth analyses of Latin@s' success in undergraduate education writ large shed light on disparities between Latin@ women and Latin@ men. Cole and Espinoza (2008), for example, highlighted how Latin@ women as undergraduate STEM students are often more academically successful (e.g., higher GPA and degree completion rates) than their Latin@ men counterparts. While Latin@s remain largely underrepresented in STEM as a racial group, Latin@ women are more underrepresented than Latin@ men due to lowered confidence and weakened academic self-concept resulting from the masculinized nature of these undergraduate STEM spaces including engineering and mathematics (Camacho & Lord, 2014; Cole & Espinoza, 2008). The variation of undergraduate STEM educational experiences among Latin@ women and Latin@ men, point to gendered and racial influences on their participation and identities that can be better understood using

intersectional lenses of analysis. With undergraduate mathematics including calculus serving as a critical filter for STEM-intending majors, intersectional analyses of Latin@ undergraduate students' mathematics experiences offer insight into not only turning points that re-routed their academic trajectories, but more importantly, their strategies in successfully navigating undergraduate mathematics as a gendered and racialized space (Chen, 2013; Rasmussen et al., 2014).

#### **4.2 Literature Review**

Mathematics has been well documented as a gendered and racialized space for marginalized populations including women (Boaler, 2002a; Mendick, 2006), African Americans (McGee & Martin, 2011; Stinson, 2008), and Latin@s (Oppland-Cordell, 2014; Varley Gutiérrez et al., 2011). Issues of gender and race, however, have largely been studied separately in extant mathematics education research with minimal insight on how their intersections lead to varying forms of mathematics experience. For example, while such intersections have informed sampling of participants such as African American men across studies using a critical race theory lens, race was the primary focus of their analyses with considerations of how gender shaped participants' racialized mathematics experiences left implicit (Leyva, accepted).

Intersectional analyses, thus, allow for the detailing of within-group differences in how individuals make meaning of gendered and racial experiences of mathematics success. As Martin (2009) writes, "More nuanced understandings of race—understandings that do not reinforce deficit explanations for disparities in achievement and schooling experiences—must be developed among mathematics educators and policy makers if these intersections [of race, class, and gender] are to be considered" (p. 300).

Thus, higher education and mathematics education scholars are calling for research that departs from deficit perspectives and instead captures the intersectional complexities of educational success among marginalized populations in STEM (Crisp et al., 2009; Esmonde, Brodie, Dookie, & Takeuchi, 2009; Espinosa, 2011; Martin 2009; Oppland-Cordell, 2014; Patton et al., 2007; Solórzano, Ceja, & Yosso, 2005).

Furthermore, much of the foundational mathematics education research on Latin@s largely focuses on the importance of validating Latin@ students' cultural backgrounds (e.g. Spanish language) as learning tools with minimal exploration on the their other identities in mathematics (Khisty & Willey, 2013; Moschkovich, 2013). Varley Gutiérrez and colleagues (2011) acknowledge the need to examine Latin@s' experiences as mathematics students, "Latina/o students have seldom been asked for their perspectives on their classroom mathematics experiences or what insights they might provide about the possibilities of enhanced mathematics learning opportunities" (p. 27). As a result, much remains to be learned from Latin@s' experiences in mathematics especially at intersections of race with other identities such as gender, class, and immigration.

In undergraduate mathematics education, Rasmussen and Wawro (under review) have argued that considerations of such equity issues are the "next steps" in understanding how mathematics instruction can be more responsive to the cultural and linguistic diversity in undergraduate classrooms. Proceedings from the 2015 Research in Undergraduate Mathematics Education Conference echoed calls for intersectional analyses of mathematics experiences and identities. Namely, Adiredja, Alexander, and Andrews-Larson's (2015) theoretical report offered a conceptualization of equity for

undergraduate mathematics education that tasked researchers to pursue data analyses and reporting of findings with a critical awareness of the “intersectionality of identity” (p. 70).

This phenomenological study responds to these calls for research through the use of critical race theory (CRT; Solórzano & Yosso, 2002) and Latin@ critical race theory, or LatCrit, (Bernal, 2002) to characterize mathematics success as a gendered and racialized experience among five undergraduate Latin@ engineering students at a large, predominantly white four-year institution. A three-tiered analytical framework from prior work (Leyva, under review) was adopted to address the following questions detailing the institutional, interpersonal, and ideological dimensions of the Latin@ students’ mathematics success:

- What institutional structures limited or afforded the undergraduate Latin@ engineering students’ opportunities for mathematics success?
- How did interpersonal relationships with teachers, peers, and family members shape the Latin@ engineering students’ experiences of undergraduate mathematics success?
- To what extent did the Latin@ engineering students perceive mathematics success as a gendered and racialized form of experience? What strategies did the Latin@ students pursue in navigating gendered and racial discourses of mathematics success?

### **4.3 Theoretical Framework**

Critical race theory (CRT) in education is a perspective that “foreground[s] and account[s] for the role of race and racism” (Solórzano & Yosso, 2002, p. 25) in efforts to

disrupt racism and other intersecting systems of societal oppression (e.g., sexism, classism) in schools and classrooms. One of the CRT tenets in educational research is recognizing what Crenshaw (1991) coined as the *intersectionality* of experience referring to the mutual constitution of oppression at intersections of race, class, gender, and other identities (Solórzano, 1998). As a “close cousin” to CRT, Latin@ critical race theory (LatCrit) examines the intersectionality of experience among Latin@s in relation to issues such as culture, immigration, and language that often go unaddressed under CRT (Bernal, 2002).

#### 4.4 Methods

Phenomenology informed the study’s methodology of collecting and critically examining multiple “texts of life” (Creswell, 2013) to detail the phenomenon of mathematics success among the five Latin@ undergraduate engineering students at a large, predominantly white university. Under the CRT perspective, these texts of life correspond to the analytical construction of mathematics *counter-stories* (Solórzano & Yosso, 2002), or personal narratives challenging racial discourses of mathematics ability, in this case, among marginalized groups including Latin@s. Counter-storytelling allows for explorations of how marginalized individuals’ stories discursively map onto instances of disconnect and oppression as well as affirmation and empowerment that shape their negotiations of mathematics success at intersections of race, gender, and other identities (Martin, 2009). The previously discussed theoretical perspectives, thus, informed the methodological detailing of Latin@ study participants’ intersectionality of mathematics success vis-à-vis their counter-stories and classroom experiences as undergraduate engineering students at a predominantly white university.

Qualitative case study methodology (Miles & Huberman, 1994; Yin, 2003) was adopted such that the undergraduate Latin@ engineering students' mathematics counter-stories were the "cases," or units of analysis, used in documenting their mathematics success as a gendered and racialized experience. These mathematics counter-stories were constructed by triangulating multiple data sources including mathematics autobiographies, individual semi-structured interviews, and a focus group discussion. Layering prior intersectional work's methodology (Leyva, under review), observations in the Latin@ engineering students' undergraduate mathematics classrooms were also incorporated in the analytical construction of these counter-stories. A three-tiered analytical framework from prior work (Leyva, under review) mapping onto the study's three research questions was adopted to explore the institutional, interpersonal, and ideological influences on the undergraduate Latin@ students' mathematics success.

### **Research Context & Study Participants**

This study took place at a large state university in the northeastern United States during the 2014-2015 academic year. Less than 15% of the 2011-2012 graduating class was Latin@. These Latin@ graduates earned only 10% of the university's conferred degrees in STEM areas. Less than 3% of the university's full-time faculty during the fall 2012 semester was Latin@.

Latin@ participants were purposefully recruited based on criteria informed by scholarship on "successful" underrepresented students in STEM (Cole & Espinoza, 2008; McGee & Martin, 2011; Stinson, 2008). Five Latin@ students (2 women and 3 men) were recruited from the university's chapter of the Society of Hispanic Professional Engineers (SHPE), a national organization aimed at empowering the Hispanic

community in realizing its potential in engineering through STEM outreach and professional networking. To focus the analysis and highlight variation across gendered and racialized mathematics experiences, findings presented here attend to a single gender-race intersection (namely, man/Latin@) and look across the reflections and undergraduate mathematics classroom experiences for two Latin@ men (Daniel and Brian).

### **Data Collection**

Four types of data were collected: (i) mathematics autobiographies, (ii) classroom observations, (iii) semi-structured individual interviews, and (iv) a focus group. Informed by CRT methodology (Solórzano & Yosso, 2002), these data sources were triangulated for the analytical construction of the Latin@ men's mathematics counter-stories as undergraduate engineering students at a large, predominantly white university. Field observations in the Latin@ men's undergraduate mathematics classrooms, in particular, provided situated insights to complement reflections of their mathematics experiences. Excerpts from the Latin@ men's mathematics autobiographies as well as stimulus-recall of potentially critical moments from classroom observations were revisited in interview and focus group spaces (Ericsson & Simon, 1993).

Each Latin@ man completed a mathematics autobiography prior to his first interview. The autobiography prompt asked the Latin@ men to write a three-to-four paragraph story that chronicled key experiences associated with their success as mathematics students. More specifically, the Latin@ men were asked to describe at least one positive and one negative mathematics experience and connections (if any) to their Latin@ identities. To conclude their autobiographies, the Latin@ men reflected on



similarities and differences between high school and undergraduate mathematics as well as what contributed to their continued success in mathematics at the university level. Autobiography excerpts were incorporated in the first interview to probe for institutional, interpersonal, and ideological influences on the Latin@ men's mathematics experiences.

Drawing on extant research on gendered and racialized dynamics in mathematics classroom learning (Barnes, 2000; Esmonde & Langer-Osuna, 2013), a series of field observations were completed in the Latin@ men's undergraduate mathematics classrooms. These classroom observations included three 80-minute lectures and three 80-minute problem-solving workshops, or recitations, per semester. The central purpose of the classroom observations was detailing the instructional and relational spaces of the mathematics classrooms noted in interpersonal interactions, student participation, and nature of mathematics instruction. Field notes were taken about the Latin@ men's engagement throughout the lectures such as volunteering solutions, asking questions, communicating with classmates, and/or lack thereof. Such behaviors provided insight into students' (sub)conscious moves in navigating the gendered and racialized spaces of undergraduate mathematics classrooms (Esmonde & Langer-Osuna, 2013).

Throughout the academic year, the Latin@ men completed three 60-minute, semi-structured individual interviews. All interviews were audiotaped and transcribed verbatim. The interviews were opportunities for the Latin@ men to reflect on what mathematics success was and meant to them as Latin@ men across different contexts (e.g., high school, undergraduate mathematics classrooms, home, SHPE meetings). Interview questions were structured in an open-ended manner that allowed the Latin@

men to describe varying levels of consciousness of their identities across these contexts including the mathematics classroom (Bowleg, 2008).

The Latin@ men also completed a focus group structured around three stimulus narratives based on observations in their lectures and recitation sessions. These narratives related to ideas of students taking up space, stereotypes of mathematics ability, and teacher-student relationships in the mathematics classroom. Participants were probed on the extent to which they observed such dynamics in mathematics classrooms and whether or not they saw themselves in similar situations. These focus group reflections, thus, offered insight into what the Latin@ men saw as “breaches” (Herbst & Chazan, 2011) of the undergraduate mathematics classroom experience. The focus group discussion was audiotaped and transcribed verbatim. (Appendix 1 contains the protocol for the focus group discussion.)

### **Data Analysis**

Phenomenology guided data analysis by identifying patterns across the Latin@ men’s counter-stories to detail the phenomenon of mathematics success as a gendered and racialized form of experience (Creswell, 2013). More specifically, the mathematics counter-stories were openly coded as “three-dimensional narrative inquiry spaces” (Creswell, 2013) to make meaning of how they negotiated their academic success and identities vis-à-vis mathematics classroom and SPHE experiences (institutional), relationships with teachers, family, and peers (interpersonal), and beliefs of mathematics success and being Latin@ men (ideological). Open codes, thus, were used to identify the institutional, interpersonal, and ideological influences on mathematics success while axial

codes examined the intersectionality across the Latino@ men's experiences (Bowleg, 2008; Creswell, 2013).

Axial coding was used to identify the undergraduate Latin@ men's *strategies* in being mathematically successful with attention to *contextual* influences on these strategies and the *consequences* of their respective strategies (Strauss & Corbin, 1998). While some axial codes were specific to individual identities (e.g., race, gender), other axial codes corresponded to different intersections of these identities such as gender-race (Bowleg, 2008).

Implicit reflections and observations of the Latin@ men's intersectionality of mathematics success were made explicit in the data analysis and interpretations. To do this, intersectionality "subtexts" (Banning, 1999) in the Latin@ men's interview/focus group responses and classroom behaviors were identified in the analytical construction of their mathematics counter-stories throughout the length of the study.

Validity was reinforced through triangulation of collected data, memoing, and member checking. Dated memos and annotations traced the development of the study's data interpretations including emergent themes, needed clarifications, and key connections to the research literature. Instances of confirming and disconfirming evidence were also noted to appropriately refine the study's coding scheme and emergent themes in efforts to accurately capture the phenomenon of the Latin@ men's undergraduate mathematics success.

Furthermore, I brought awareness of my positionality to pursue data analysis with strong subjectivity and build nuanced understandings of the Latin@ men's mathematics success. In addition, I developed positive rapport and mutual trust with the Latin@ men

supported by our mutual identifications as Latin@ men and STEM majors (Glesne & Peshkin, 1999; Lincoln & Guba, 1999).

## 4.5 Findings

The following section presents the counter-stories of Daniel and Brian's mathematics success as a gendered and racialized experience. These counter-stories look across the Latin@ men's high school and undergraduate mathematics experiences including the courses in which they were enrolled during the time of this study. The relational spaces of their respective undergraduate mathematics classes including lectures and recitation sessions are also presented based on classroom observations. A section of each counter-story closely examines the gendered and racialized intersectionality of the their experiences with an analytical focus on how they negotiated discourses of mathematics (or academic) ability and success with their identities as Latin@ men. The findings section concludes with a cross-case analysis detailing the similarities and differences across the two Latin@ men's experiences of undergraduate mathematics success. (Appendix 2 contains seating charts representative of Daniel and Brian's mathematics lecture and recitation observations.)

### 4.5a Daniel

**High school mathematics experience.** Daniel is a fourth-year, Dominican- and Ecuadorean-American mechanical engineering student who saw himself as not being good as well as hating mathematics. He attributed this to his early high school experience when he was not one of the "smart kids" who was recommended for the accelerated algebra program in eighth grade. Algebra I was his least favorite mathematics class because he felt as though his teacher "stopped caring about the class"

and focused more on managing students' behavior than teaching mathematics. He took the class during his years as student in a predominantly African American and Latin@ magnet public high school into which he was competitively accepted after elementary school. Daniel's peers perceived algebra I as a "remedial" class considering how many students who had completed the accelerated algebra course took algebra II instead of algebra I during their first year of high school. Daniel was one of the three pre-algebra students in eighth grade who were admitted into the competitive magnet public school.

After sophomore year, Daniel and his family moved and transferred to a predominantly white high school where he took his most favorite mathematics class, precalculus. He attributed his positive experience to having a teacher who seemed passionate about the subject and cared about his students' success. Daniel saw precalculus as a "remedy" for his hatred of mathematics and reflected on paying attention and participating more than he did in his algebra I class. In addition, Daniel described establishing a "brotherly relationship" with his precalculus teacher who also served as his track coach. In the following interview except, Daniel reflected on how he saw his precalculus teacher pushing him and his classmates toward success in mathematics:

Many of my quizzes were poor, but he said you're never gonna always get the answer right. Math is something that you're gonna have to work at. He'd always push us - not just me, everyone in the class. Even the kids who would get really good grades in the class, he would say, 'You could do better. Just keep trying, keep practicing.' It was very different from my algebra 1 professor - such a contrast. (Interview)

This motivational push from Daniel's precalculus teacher illustrates how the teacher held a view of mathematics ability as incremental and related to effort rather than based on innateness or genetics. It is also important to note how Daniel's enjoyment of mathematics is largely influenced by his teachers' ability to demonstrate a strong

connection to the subject and build supportive relationships with their students. In addition, Daniel looked back on how his precalculus teacher “pushed [him] in every aspect of life” as it was during that year when he felt a reaffirmation of his purpose in going to school and studying mathematics. This encouragement that Daniel received from his precalculus teacher can be likened to the concepts of *apoyo*<sup>12</sup> (Auerbach, 2006) and *consejos*<sup>13</sup> (Delgado-Gaitan, 1994) in Latin@ culture. Daniel alluded to receiving similar forms of moral support and advice (as described later) from his father based on his experience in successfully graduating as an electrical engineering major at a community college.

Daniel shared his frustrations about the disparities between resources and mathematics learning opportunities at his original and new school districts. He commented on feeling as though his pre-algebra teacher “cared more” about her algebra students who were deemed the “smart kids” in the school by the principal and peers. Daniel, for example, looked back on visiting the algebra class and noticing how the nature of the teacher’s instruction differed from that in pre-algebra. He remarked during an interview, “Whenever someone in [algebra] would ask a question, she’d immediately answer it, draw diagrams, and such and such perfectly for them. But in pre-algebra, there was not that enthusiasm.” Such instructional disparities brought Daniel to feel angered about how his mathematics teachers “let [him] down” and questioned “why couldn’t they just put us [the students] all in algebra.” Daniel, therefore, expressed awareness of how

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<sup>12</sup> Apoyo is defined as the emotional and moral support that Latin@ parents offer their children for their well-being and self-confidence for academic advancement (Auerbach, 2006; Ramos, 2014).

<sup>13</sup> *Consejos* are defined as cultural narratives of perseverance and resilience that parents share with their children for their educational advancement (Delgado-Gaitan, 1994; Ramos, 2014).

teachers' views of students and their mathematics ability varies across tracks and how this shifted the nature of pedagogy in the classroom. At the district level, Daniel found it “really weird” how all ninth grade students in his second high school already completed algebra in eighth grade. This realization made Daniel feel as though the lack of resources in his former school district positioned students to be “destined to fail” unlike the situation in his second high school.

**Undergraduate mathematics experience.** At the university, Daniel failed calculus I twice and was placed on academic probation. He attributed failing the course the first time to knowing that he would be given a second chance of re-taking the course. With passing his other required engineering courses, Daniel described feeling a sense of complacency in not having to try as hard in calculus that resulted in failing it again. Daniel saw being placed on academic probation as a source of motivation for “not failing” in college anymore and an opportunity to learn more about himself including his purpose as an undergraduate engineering student. Family largely shaped Daniel's purpose in his engineering studies in terms of not letting down his mother, father, and brother. In the following excerpt, Daniel characterizes his academic impetus as a sense of “guilt” associated with school failure that he avoids by studying as far in advance as possible and working toward graduation:

My mom was getting sicker and sicker so then it hit me that maybe she's not gonna be around forever. And I remember she would always talk to me about “Oh, I can't wait to see you graduate.” It lit a fire under my butt – I have to finish this. I have to graduate so she can see me graduate before anything bad happens... That's the worst part when your parent doesn't get mad at you. They make you feel guilty. He [His dad] was good at that, and I feel like he knew he was good at that too. They always supported me. My brother, too, he would always say, “[Daniel], I want you to be an engineer, I want you to represent the Peralta family. (Interview)

Such family encouragement was what helped Daniel overcome “one of the lowest points in [his] life” – namely, the scary experience of being placed on academic probation.

Daniel describes such resilience as keeping him determined and positive during academically challenging times as an engineering student. He commented, “I can always look back and say that I was in a worse position and there was still people that like believed in me. That made me not give up so if I can do it [then], I can definitely do it now.” Daniel’s drawn connection between his undergraduate STEM pursuits and his family’s expectations for success is an example of *familismo* (Sáenz & Ponjuan, 2009), a sense of loyalty or responsibility to the Latin@ family unit. In Daniel’s case, he feels as a sense of indebtedness to his mother, father, and brother in graduating as an engineering major to demonstrate his loyalty to them and “represent” the family through his success.

Finally passing calculus I, therefore, was a “turning point” in Daniel’s mathematics experience that challenged his views of not being good at mathematics and made him feel as though he “could becoming an engineer.” He described this time as his “metamorphosis” in studying undergraduate mathematics largely influenced by his close and supportive relationship with his third calculus professor, Benjamin. Daniel perceived Benjamin as an “uncle-grandfather hybrid” who, as a mathematics professor, contrasted from others who “felt like robots.” Benjamin’s more personable nature, as Daniel describes below, was characterized by his sense of humor, retellings of childhood stories living in Honduras, and shared pieces of advice while teaching the calculus course.

After he started saying jokes and started being friendly, he looked like he kinda wanted to be there. That’s when I started seeing him more. He had like more human traits. I’m not trying to dehumanize any other professors... That’s the way we perceived them, and I know it wasn’t just me because other people started to come to class because they started enjoying it. But, yeah, he was the coolest professor I’ve had. (Interview)



Benjamin's "magnetism" as a professor is what Daniel saw as contributing to his shift as a mathematics student. This was the first undergraduate mathematics course where he sat toward the front of the lecture hall and voluntarily went to the professor's office hours. In addition, Daniel described Benjamin as being passionate about what he taught and prioritized his students' understanding of the material as evidenced in offering individualized student support and alternative explanations during class. It is noteworthy how this characterization of Benjamin's mathematics teaching paralleled the passion and support that Daniel greatly valued from his high school precalculus teacher. During our focus group discussion, Daniel drew on his experience as a student in Benjamin's calculus class to capture how he feels "more comfortable" when he has Latin@ mathematics teachers in high school and college. He recalled an office hour visit with Benjamin when he realized that Benjamin and him both spoke Spanish and how "things just started clicking together" both in terms of the mathematical content and their teacher-student rapport. This office hour experience goes beyond Daniel simply connecting with Benjamin as his teacher as it captures how the relational space between them shifted and allowed for family-like support through *apoyo* and *consejos* that Daniel's precalculus teacher and father also provided.

In addition to building supportive relationships with faculty, connecting and working with fellow engineering peers was important to Daniel's undergraduate mathematics success. Daniel reflected on how his affiliation to STEM support programs at the university including SHPE facilitated making these peer connections throughout his engineering studies. Self-identifying as an introvert, Daniel did not realize the value of forming and working in study groups until his junior year of college while taking

differential equations. It was at this time when he began working with two friends who he met through the engineering school's educational opportunity program for financially underserved students. Daniel's father, a community college graduate in electrical engineering, shared *consejos* that encouraged him to work with his classmates as doing so had worked for him during his undergraduate years. His positive experience in study groups confirmed his father's *consejos* as Daniel saw these peer relationships as "allow[ing] for different perspectives" that he probably would not have considered working alone. In addition to studying together, Daniel reflected on how the attrition of engineering peers in the educational opportunity program as well as his academic probation standing "[made] the relationship of [those] remaining... so much tighter."

Daniel expressed feeling a family-like sense of comfort, much like his relationship with Benjamin, when interacting with Latin@ engineering peers during the SHPE meetings.

When I first went to SHE in freshman year, it felt like home... I remember when I was there, I felt very comfortable like I was among family like other Hispanics and we can just tell jokes about Hispanic things like parents throwing chancletas. (Interview)

He went further to describe how SHPE participants are "affected indirectly [from] being Latino" with seeing other Latin@ engineering students at the university who are not frequently seen in mathematics and other STEM classroom spaces. These reflections capture how SHPE served as a *counter-space* (Gutiérrez, Rymes, & Larson, 1995) for Daniel that carved an institutional space where underrepresented Latin@ students like him can connect and support each other academically and emotionally in being as well as seeing themselves as successful undergraduate engineering majors. More specifically, Daniel commented on how building these SHPE peer connections with other Latin@s

“motivate[s] you to finish... [and] be there when they graduate as well.” It is noteworthy how these interpersonal ties that Daniel established across the educational opportunity program and SHPE meetings are characterized by the blending of academic and moral support, or *apoyo*, that also shaped Daniel’s influential relationships with his father, high school precalculus teacher, and Benjamin as a mathematics student.

Advanced calculus for engineering students was the undergraduate mathematics course that Daniel was taking during the time of the study. He described feeling as though he “could’ve done better” in the advanced calculus course because it was more challenging to connect with his professor, Henry. Even though Henry and Benjamin were similar in their sense of humor and offered pieces of advice, Daniel commented on how Henry’s heavy Eastern European accent presented a barrier that made asking and answering questions challenging and thus “really messe[d] up the relationship between him and the students.” Daniel found Henry’s verbal and written feedback on his assignments to be the most beneficial aspects of his advanced calculus course. Daniel reflected on how this assignment feedback was both motivational and helpful in identifying specific topics to study, bringing his grades to improve over the semester. The impact of Henry’s relational distance from his students and the supportive nature of his assignment feedback on Daniel’s advanced calculus experience, thus, further illustrate the importance of strong teacher relationships in Daniel’s mathematics success.

In comparing the mathematics classroom experience between high school and college, Daniel described the latter as being a “fly or die” situation whereas the former allowed more room for students to make and learn from their errors with available opportunities of teacher support. Daniel expanded on this contrasting dynamic during the

focus group by discussing the higher stakes associated with students making contributions in the undergraduate mathematics classroom. Considering how classmates in large undergraduate lectures may not know each other as well as they would in smaller high school mathematics classrooms, volunteering an incorrect answer or asking simple questions may bring others, particularly those deemed as having higher status, to judge them as being less mathematically able. Daniel described how this is problematic as the volunteering student comes to be “closed off” to building relationships with these higher-status peers. He draws on this dynamic of “no one want[ing] to be wrong” to make meaning of why he and many classmates remain silent in undergraduate mathematics classroom spaces. When Daniel and other focus group participants were asked if they have observed students who depart from such silent behavioral norms in the classroom, Brian replied that they are usually “Indian, white, Asian, not Hispanic” and Daniel then affirmed, “Yeah, it’s usually the same kids who go above and beyond.” These reflections capture how innate views of mathematics ability are operating in undergraduate mathematics classrooms that position Latin@s and other racial minorities as being innately not as good in mathematics compared to higher-status classmates including whites and Asian Americans. This, therefore, structures a racialized hierarchy of mathematics ability in undergraduate mathematics classrooms such that Daniel and fellow Latin@ study participants see themselves as positioned lower along the hierarchy and thus more vulnerable to jeopardizing their status in the classroom (Martin, 2009).

**Intersectionality of mathematics experience.** Daniel reflected on how being Latin@ shaped his mathematics success by feeling the need to “prove people wrong” and “destroy that stereotype” of Asians being good at mathematics and sciences. He

perceived these racial stereotypes as serving as “barriers” for Latin@s and other minorities from being similarly seen as mathematically able. His continued pursuits of an engineering degree and mathematics success, thus, are ways in which Daniel saw himself as “not falling victim to stereotypes” so he can broaden opportunities for fellow members of the Latin@ community. Daniel asserted that although he has not observed explicit forms of racism against Latin@s in STEM, “it’s there just subtly.” To illustrate such subtlety, Daniel reflected on peer interactions after graded undergraduate mathematics exams are returned in the classroom. He described how his eastern Asian American and Indian American friends would ask him, “What’d you get?,” which he interpreted as them adopting a “subtle change of words” to avoid explicitly asking him, “Did you fail?” This interpersonal dynamic is an example of how the lack of discourses that position Latin@s as mathematically able brought Daniel to experience his eastern Asian American and Indian American friends’ question about his exam grade as a racial microaggression of his mathematics ability (Yosso, Smith, Ceja, & Solórzano, 2009).

At the intersections of his identities as Latin@ and as a man, Daniel reflected on managing two sets of “obligations” as a mathematics student – one as a Latin@ and one as a man.

From the Latino side, it’s because I don’t wanna fail. From the man side, it’s because I feel as though I’m obligated to pass because I’m obligated to succeed. The way they intersect, I feel as though... it comes down [to] just not failing... I don’t wanna show negative aspects to either side. (Interview)

His sense of a racial obligation stems from Latin@s’ absence in narratives of mathematics ability commonly associated with whites and Asian Americans as previously described. In terms of gender, Daniel drew on his older brother’s claim that “you’re not a man until you live alone [and] you pay your bills.” Such gendered

perception of a man's obligations aligns with masculinized notions of independence and upward social mobility in the United States as well as the gendered cultural narrative of Latin@ men as family breadwinners. This, in turn, shaped Daniel's value of future job security as a key impetus for being successful as an engineering major. His sense of "obligation" as an successful engineering student also maps onto the notion of *obligación* among Latin@s that, when associated with the Latin@ family unit and community at large, presents a sense of moral imperative that Daniel perceived as driving his higher education pursuits. Furthermore, it is important to note that Daniel's focus on "not wanting to fail" after being placed on academic probation at the university and thus not "be[ing] a statistic" challenged the intersectional discourses of Latin@ men as dropping out of college and being unemployed.

**Relational space of undergraduate mathematics classroom.** Daniel's advanced calculus professor Henry, an elderly man of eastern European descent with a heavy accent, presented his lessons by projecting lecture notes and talking through the mathematics while sitting at his desk in front of the classroom. Students, for the most part, including Daniel passively wrote the lecture notes that the professor promised to upload onto his personal website after class. There were minimal instances of student questioning for understanding aside from asking students what would be steps involved in a procedure. Daniel mostly watched the professor lecture throughout the class with the exception of moments when he wrote down notes following the professor's comments related to upcoming exams such as "Don't forget this after Thanksgiving."

Less emphasis was placed on students' conceptual understanding of the mathematics in light of the professor's frequent disclaimers such as "Don't forget to

memorize... [and] memorize them correctly” and “Just memorize the equation.”

Interestingly, when noteworthy solutions were discussed in class, the professor made comments such as “Write this down and make sure you perfectly understand what happened and why” without highlighting the mathematics involved. During the second set of class observations, the professor projected solutions for a quiz while outlining “very unpleasant mistakes” that students made in their submissions. There were no follow-up discussions about why these “mistakes” were mathematically incorrect and why the projected solutions made sense.

While presenting the lecture notes, the professor regularly asked the entire class to complete small, related mathematical tasks independently and then sought individual volunteers to share their solutions. These were the only moments in the advanced calculus classroom where the professor was observed interacting and building relationships with individual students. When the professor sought volunteers to share their work, two southeastern Asian men are the ones who most frequently shared their solutions without being prompted by the professor. Their contributions were both positively and negatively acknowledged in the classroom with professor comments like “Yes, he said it correctly” and “No, I have a feeling that you never start from the beginning.”

When the professor directed questions toward specific students in the class, he tended to focus on the men sitting at the two long tables on the left of the classroom including two white men, an African American man, and a Latin@ man. His directed questioning, however, seemed to be used as a mechanism in keeping these men on-task in class. Daniel alluded to this in his interview by describing how the professor would “call

someone out but, other than that, he won't try to talk with them [the students in the class]." During the first set of classroom observations, the professor asked the Latin@ man sitting in front of Daniel about whether or not he found the value of a variable. After this student asked for clarification about his question, the professor asked, "Did you just wake up?" with a smile to which the Latin@ man replied, "No, I am awake. I am just confused" with resistance in his intonation. The professor then proceeded to ask one of the southeastern Asian men for the variable's value. When the Latin@ man volunteered an answer during the second set of class observations, the professor dismissed his contribution by saying "I agree with you, but there is something missing" and again turned to the same southeastern Asian man for his contribution. While it seems as though the professor attempted to use humor as a device for building rapport and keeping this group of men on task, the men seemed resistant in connecting with him as they were being positioned consistently low along the racialized hierarchy of mathematics ability described earlier. The two white men and African American man, for example, covered up their teasing remarks about the professor's heavy Eastern European accent by pointing to their class notes while making them. One instance when these men audibly laughed, the professor sarcastically commented to the entire class, "These guys communicate with their fingers."

Such forms of student resistance were not limited to this group of men. During my second set of observations, an Eastern Asian woman sitting next to me seemed visibly frustrated after reviewing her returned exam paper. The woman tapped her pen loudly on her desk, made frequent snapping noises with her mouth, and audibly sighed "Oh God" multiple times while the professor discussed the students' various mistakes on the exam.



At one point, the woman slammed a binder on her desk and asked the Indian man sitting in the back for both class observations for his returned exam paper so she can compare her solutions with his. She then returned the exam when she appeared done making her comparisons and corrections on her paper. For the remainder of the class period, the woman did not take any notes related to the presented lecture and instead compared what looked like the professor's posted lecture notes to entries in the mathematics textbook solution manual.

#### **4.5b Brian**

**High school mathematics experience.** Brian is a Peruvian-American electrical engineering student in his first year at the university after transferring from a community college where he completed an associate's degree. His mother and him immigrated to the United States when he was twelve years old and felt as though he was taking steps back in his mathematics studies compared to the more advanced curricular structure in Peru. Brian attended a predominantly white high school in a town that was split between lower-class and middle-to-upper-class housing. High school was a turning point in Brian's mathematics experience when he began to feel as though he was "plainly bad at math" particularly after his second mathematics class, algebra I. Brian reflected on how algebra I was his most negative mathematics experience because his Mexican teacher, someone who he looked up to, quit her job in the middle of the school year because she was struggling with managing student behavior in his class.

She decided to leave the class, like quit on us because she felt she wasn't getting anything done. So you kinda felt like she just left you there and she just didn't care about you like they didn't want to help you out. She just gave up on you so it just kinda like lowers down your self-esteem a little bit. You kinda feel like you weren't important enough for her to like focus and helping you out. (Interview)

Here we see how Brian viewed his algebra I teacher quitting her job as a form of abandonment without considerations of the connections that she may have made with students in the class. Brian discussed how much of the misbehavior in the algebra I class was caused by the school's "troublemakers," a group of low-income and Hispanic boys who recently immigrated to the United States. With the teacher giving up on the entire class, Brian felt as though the Mexican teacher was associating him with "the bad ones or deviant ones" in the class and thus "brought [his] self-esteem down when it came to math" for the rest of his high school years. This experience captures how connections with his teachers and being perceived as a "good" student influenced his positive self-perceptions as a mathematics student.

Feeling unprepared for future high school mathematics classes and "not good at math" after struggling in algebra I, Brian recalled being "more insecure" and "more nervous" in his algebra II class with mostly white peers and only one other Latin@ student. He discussed how his insecurities as a mathematics student were more pronounced in moments when his white algebra II teacher would direct questions at him in front of the entire class. Brian felt as though answering these questions incorrectly would cause classmates to think, "You're dumb or like you're stupid because you don't know this simple thing." These reflections illustrate how Brian's heightened sense of being racially outnumbered as a Latin@ coupled with his lowered confidence in mathematics ability made his classroom participation risky. Much like the racialized vulnerability that Daniel felt with participating in undergraduate mathematics classes, Brian felt a sense of responsibility as one of the two Latin@s in the algebra II class to answer questions correctly in order to protect his as well as the Latin@ community's

status as mathematically able. The teacher's directed questioning and Brian's emotional labor of managing his perceived ability captures how the racialized hierarchy of mathematics ability operated in the algebra II class.

Prior to enrolling in the community college, Brian reflected on the challenges of receiving institutional support about opportunities for pursuing higher education. He recalled how his high school guidance counselors "treat[ed] everyone the same" without acknowledging students' differences in financial backgrounds so they assumed that his family was just as informed about higher education opportunities as his middle- and upper-class peers. This limited Brian's access to information such as financial aid and application procedures since his parents were unfamiliar with the higher education system in the United States. Brian recalled how his older sister pursuing a nursing degree at a community college was only person who supported him with *consejos* on navigating the application process and high school-to-college transition experience. Considering the underrepresentation rates of Latin@s in higher education, Brian's experience raises considerations on the importance of broadening high school seniors' and their families' access to information about higher education opportunities across class, language, and other differences.

**Undergraduate mathematics experience.** Brian perceived his three years at the community college to be his most positive mathematics experience. At the time, he experienced another turning point where he saw himself as being good and "actually lik[ing]" mathematics unlike his high school years. He attributed this shift in his self-perception as a mathematics student to the community college faculty members who seemed to be "into teaching mathematics" as well as "more involved with helping the

students” both in their mathematics coursework and transferring into a four-year institution. In the following excerpt, Brian reflected on the nature of support that he received from his community college professor who taught two of his mathematics courses.

He’s had years of math and he actually helped me out a lot. I used to go to his office hours after class and he would be excited about it and he would be like, “Yeah, yeah, you can come in.” He would teach me the subject and he would actually be nice about it... I did great in the class and that’s when I got my first A in college in math. (Interview)

Here we see Brian characterizing his community college professor as both accessible and approachable for academic support outside of the mathematics classroom. In addition, the professor’s enthusiasm for the subject and helping students contributed to building a relational space with Brian that motivated his mathematics success unlike the disconnect he felt with the subject during high school. Brian, furthermore, contrasted the professor’s instructional approach and student support opportunities with the impression of mathematics teaching that he had gotten from his high school teachers – namely, “cover[ing] the material and get[ting] it done and that’s it.” Considering the value that Brian placed in connecting with mathematics teachers, these shifts in Brian’s perception of mathematics teaching and his mathematics ability as a community college student are noteworthy in his trajectory as a mathematics student. This positive experience at the community college brought Brian to consider the pursuits of minoring in mathematics.

Along with this professor, Brian remarked on the influence of an Argentinian electronics engineering technology faculty member at the community college with whom he had a “really big talk” about his future STEM pursuits. This was during a time when Brian was considering the possibility of pursuing electronics engineering technology, a

major that was less math-intensive than an engineering degree at another four-year university.

He asked me why do I wanna do that, like that's really weird I've never heard of someone majoring in that who wants to minor in math - why don't you just do engineering? And he had a big talk about me; how we Hispanics should strive to do better in colleges and graduate so we can...not be looked down upon in this society. And how the majority over here always looks at us like the lower beings in the economy especially in the job market...He told me to be one of those persons who tries to make yourself look good and also your community and he told me it's better to change the major now than wait later on and that's when I decided to stay in community college for one more year so I keep studying mathematics and physics. (Interview)

This conversation captures how a relational space was established between the Argentinian professor and Brian that allowed for providing support that went beyond academic advisement. The professor acknowledged Brian's commitment and academic progress as a Latin@ in mathematics to frame his encouragement of Brian pursuing a more math-intensive major like engineering. While doing so, the professor commented on how Brian's completion of such a competitive degree like engineering would position him well professionally and thus challenge positionings of Latin@s as lower along the American racial hierarchy of professional advancement. With the professor's use of the collective "we" in his extended advice, we see how his mutual identification with Brian as Latin@ contributed to carving a relational space characterized by the blending of academic and emotional support to motivate Brian's perseverance as a Latin@ in undergraduate engineering education.

The Argentinian professor's provided support, thus, maps onto the notions of *apoyo* and *consejos* in Latin@ culture such that, in this case, took form as moral support and narratives of empowerment that motivated Brian's decision to continue studying mathematics and pursue an engineering degree at a four-year institution. Brian reflected

on how such moral support from this professor as well as other community college mathematics faculty members was what encouraged him the most to be successful in mathematics and as an engineering major.

My mathematics professors back in community college. They were really pushing you to do it and also my professor for engineering technology, they were really encouraging. They would actually sit down and talk to you from their personal experiences and actually bonded. I became friends with the professors over there... I think that was the biggest motivation: the professors actually pushing the students to actually do it. (Interview)

In this “friendly” relational space that Brian described, we see *apoyo* in the community college faculty members’ empowering support in “pushing the students” to be successful in transferring to a four-year institution and, in Brian’s case, pursuing a math-intensive major. *Consejos* are observed in how the faculty members spoke from their own experiences in higher education to frame their advice in boosting Brian’s self-esteem as a mathematics student and preparing him for what he should be “expecting when [he] transfer[s]” to a four-year college or university. In contrast to Brian’s high school teachers who “did not have a great influence in [his] life,” his community college mathematics professor contributed to a turning point in recognizing his potential for mathematics success through their relational support in and out of the classroom.

Despite this encouragement and support, Brian reflected on his challenging experience of transferring from a community college to the four-year university while living with his family. One struggle was his 30-minute commute from home to the university that frequently caused him to be late for his mathematics lectures and recitation sessions. As a commuter student, Brian felt as though his time on campus was limited and thus prevented him from establishing strong peer connections outside of his classes. He recalled how connections with more experienced peers after high school

were valuable in motivating him to pursue a degree at a four-year university. These peers provided him with advice from their personal experiences, or *consejos*, about having successfully transferred from the community college to four-year institutions, much like the *consejos* that Brian received from his community college mathematics professors. Brian discussed how the small number of peer connections that he made at the university was mainly through his engineering major classes and not as much in his mathematics classes. Even though enrollment sizes in the engineering courses were higher than in his mathematics lectures and recitations, Brian described how there were more structured opportunities in the engineering courses to work together on challenging projects and “actually get to know those people.” (Collaborative problem-solving workshops during recitation sessions are only part of the curricula for the first- and second-semester calculus courses at the university.)

Viewing peer networking as critical to his success as an engineering major, Brian discussed needing to make sacrifices in not returning home immediately after his classes so he could join organizations like SHPE where he can more readily connect with peers “available to ask [them] questions” and “feel more as if [he] belong[ed] to the university.” It is important to note how the SHPE organization through its weekly meetings and study group sessions carved peer networking opportunities that facilitated Brian’s sense of connectedness to the university at large as a commuter student. Furthermore, Brian’s sense of belongingness in SHPE allowed the organization to become a space to which he can escape from “family problems” like his parents’ ongoing divorce and discussions of bill debt that did not allow him to focus on schoolwork. Brian, much like Daniel, reflected on the motivation that he received to be successful as

an engineering major through building relationships with fellow Latin@ peers at SHPE meetings.

And it actually motivates me because I see another Latino or other people doing the same thing I'm doing so it encourages you like, "Oh, this person is doing the same thing then I'm not just by myself." So it kinda encourages you to keep moving forward with them. (Interview)

These reflections on SHPE are important as they illustrate how the student organization as a counter-space provided Brian with the academic and social support to seeing himself as a successful Latin@ engineering student who belonged at the four-year university. In addition to supporting each other with homework and exam preparations through structured study groups, Brian commented on how SHPE also allowed for informal networking to receive "inside information about professors and engineering coursework" that he felt was more challenging to access with limited time on campus as a commuter and transfer student. The services offered through SHPE, therefore, contributed to the development of a relational space between Latin@ engineering peers that supported Brian's academic pursuits through their *apoyo* (e.g., mutual support) and *consejos* (e.g., offered recommendations about professors and courses based on personal experiences).

Another struggle in Brian's transition into the four-year university was balancing his academics and family problems including his parents' ongoing divorce. Unlike the support that Daniel received from his family members like his father, Brian described how his parents "didn't really support" him or his older sister when it came to their academic success. Brian commented on how considering this lack of support, his parents "just think right now about themselves" and have not considered the extent to which the stress of their divorce impacted his progress as an engineering student. The only influence that Brian's parents had over his academics was when his father forced him to



switch majors at the community college from criminal justice to something else that would be more financially promising.

My dad literally had a talk with me and literally yelled at me and got mad at me and didn't wanna talk to me for a couple of days because he told me how the economy is and if I do that [study criminal justice], I'm not gonna be anyone in life or I'm not gonna be able to get a job with that major so he literally made me not pursue that major and he kinda made it clear that he didn't wanna talk to me until I switched majors. (Interview)

It is noteworthy to compare the quality of Brian's conversation with his father and the Argentinian professor about choosing a major. Both individuals advised Brian to pursue a major that broadened his opportunities for financial mobility. However, the father's lack of investment in his children's education prevented him from framing his encouragement in relation to Brian's potential in mathematics like the community college professor did. Brian commented that even after he switched his major and his father saw him studying mathematics for several hours in his bedroom, his father would say something like, "I can't believe you're doing this - studying math. You don't sleep." This continued lack of support from his father was frustrating for Brian who had switched majors primarily to please him. Considering the impact of the support from SHPE peers and community college professors, we can see the of receiving *apoyo* and *consejos* from institutional figures as an undergraduate engineering student that Brian was not receiving back at home.

During his first semester at the university, Brian enrolled in differential equations. He found his professor's stronger emphasis on theoretical aspects of the material (e.g., deriving formulas, proving theorems) to place him at a disadvantage when completing homework assignments and exams that focused more on problem solving. In the following excerpt, Brian commented on how this pedagogical shift from community

college faculty's focus on applications of mathematical theory to university faculty's theory-heavy lectures made his academic transition more difficult.

It's a little bit more harder because the professor, he only talks about theory in class so whenever I go to class, he only teaches us like how to get to the equation but not how to use it to solve problems so it kinda has a lot of impact right now in the class... It's like a transition from one class to another. It's just [what] I wasn't used to. I wasn't ready for the transition. (Interview)

This reflection captures Brian's struggles in adjusting to the nature of instruction between his community college and university mathematics classes that brought him to "teach [him]self" the material at home or seek help from peers. Furthermore, it raises considerations on the extent to which students are prepared prior to their four-year university enrollment for their engagement with mathematics instruction largely focused on theory.

In addition to instruction, Brian discussed the shift in the extent to which mathematics faculty members connected with students in undergraduate mathematics classrooms at the four-year university. His professor's lack of enthusiasm and minimal interactions with students in the differential equations course reminded him of feeling disconnected from his high school mathematics teachers.

The professor seemed kinda boring. He was like straight-faced, serious face every single class. I saw no excitement toward the professor. When a professor gives a good vibe like he really likes this stuff and he tries to connect with the students a lot like ask questions like 'What do you think about this stuff' or anything. He did none of that. And it was like you go over there and the whole class is just quiet. (Interview)

Here we see a contrast between the relational spaces that Brian's differential equations professor and his community college professors established in their classrooms. The different nature of these undergraduate mathematics classroom spaces brought Brian to feel "more connected to the professors" in community college and welcomed to approach

them for office hours after class. Brian also discussed how even though he can relate more to his graduate teaching assistants who are closer in age and are also students at the university, he did not feel connected to his teaching assistant for the differential equations course who was not regularly responsive via e-mail and expressed how he “wasn’t really knowledgeable” of the taught mathematical content.

Feeling as though his university professors prioritized covering content over student understanding, Brian reflected on feeling as though opportunities for asking and answering questions in the differential equations lecture were limited.

I’ve never asked a question in lecture, but I’ve seen some other kids do it. And honestly the professor has so much that he wants us to go over in the little time of the class that we have that he barely answers one and then he’s like, “No more questions. I gotta get this going.” Like he doesn’t stop and say, “Oh okay. You guys are stuck in this subject. Let me just get it more clear and then continue.”  
(Interview)

Such lack of opportunities for student participation during the lectures brought Brian to feel less compelled to attend class in order to be successful in the mathematics course. In addition, Brian reflected on how the university professors contributed to the “tense and competitive” atmosphere in the mathematics and engineering classrooms. He shared an experience of having an engineering professor who regularly communicated to the class how he does not curve grades because he wanted to “weed people out” and have them drop the course. Such messages from the professor further limits the sense of comfort that students feel with participating considering how Brian was concerned about the risk of “feel[ing] embarrassed” that the professor will remember him as not understanding the material well. These university classroom reflections, therefore, differ from the supportive learning environments that Brian’s community college professors established in order to advance rather than critically judge their students’ academic success.

When probed about who were “some other kids” asking and answering questions in the differential equations course, Brian discussed how they were “not Hispanic” and were typically the same students who were either “Indian, Asian, or white.”

The ones who will usually answer, I guess you can call them when you were back in high school, those like really shy kids, nerdy kids that just have their own cliques and don't socialize a lot, like socially awkward... The average typical high school kid that's like wanting to know everything, just wants to get a good grade, the highest in class.... It can be Indian, white, Asian, doesn't matter. It falls into any one of those 3 races. (Focus Group Discussion)

Brian's reflection illustrates the racialized opportunities in the university mathematics classrooms that granted more opportunities for white, Indian American, and Asian American students to participate than Latin@ students. Similar to the risk that Daniel perceived in participating as a Latin@ student in undergraduate mathematics classrooms, we see the racialized hierarchy of mathematics ability operating in Daniel's differential equations lecture that allowed those higher along the hierarchy – namely, whites, Indian-Americans, and other Asian Americans – to take up more space as noted in their frequent and consistent forms of classroom participation.

Brian's struggles in the differential equations course led him to drop the course so he could avoid a failing grade that would negatively affect his grade point average. Retaking the course during the spring term with a different professor, Brian commented on how his second professor's instruction allowed for students to ask questions and practice solving word problems similar to those presented in homework assignments and exams. He attributed performing “much better than last semester” to the professor's focus on student understanding and broadened opportunities for classroom participation. Despite this shift in instruction between the fall and spring semesters, Brian reflected on

how the racialized nature of who was more frequently participating continued from his differential equations lecture experience. Brian, for example, commented on how it was mainly the white students sitting toward the front of the lecture hall who seemed to be always asking questions and volunteering answers to the professor's questions. These reflections on Brian's experience in re-taking the differential equations course point to the importance of engaging instruction with opportunities for student support in building a relational classroom space that advanced Brian's undergraduate mathematics success. However, the racialized nature of classroom participation still appeared to limit Brian's contributions during lecture as he commented on how he "didn't have the guts" to respond to the professor's questions like the white students sitting toward the front.

It is noteworthy how despite Brian's observations of these racial dynamics in the university classroom, he did not experience similar forms of risk or judgment in approaching any peers with questions about his mathematics coursework. Brian attributes his comfort in reaching out to any university peer to the competitive four-year university admission leveling the playing field for all undergraduate STEM students.

Everyone treats everyone the same because I feel like they all go to the same university now. You actually made it to the university and now you're seeking to do the same [thing]... Everyone seeking engineering degree here knows that over here it's really hard so there's some kind of similarity with everyone else.  
(Interview)

Brian's view of all STEM students being in the "same position" at the four-year university is interesting to consider in relation to his perception of community college education where the "whole point... is getting people to transfer to the university." More specifically, Brian discussed how he "got used to" having whites, Indian Americans, and other Asian Americans being more well represented across his university mathematics

classrooms and thus felt a sense of ease connecting with others because they are “experiencing the same stuff [he was] experiencing” as a university student. With Brian noting a stronger sense of racial and class diversity at the community college, Brian’s feelings of sameness at the university reflect the operation of colorblind ideologies of success at the white institutional space of university and its STEM classrooms.

**Intersectionality of mathematics experience.** As a Latin@ engineering student, Brian perceived his mathematics success as serving three purposes: (i) informing home community members about pursuing a STEM degree at a four-year university, (ii) supporting his family facing financial issues, and (iii) proving others wrong about his inability to succeed as a Latin@ immigrant man pursuing an engineering major at a four-year institution. Brian described how individuals in his hometown either still in community college or not pursuing higher education “see [him] as... someone to look up to” who can offer them insights into how to be successful as a STEM student at the university. In the same way that community college professors as well as more experienced peers who transferred after community college provided him with *consejos* based on their transfer experiences, Brian viewed his pursuits of mathematics success with a sense of responsibility to inform others on how they can also be successful in higher education. Brian, for example, reflected on getting involved as a mentor in SHPE’s shadowing program so he can expose Latin@ high school students to interesting aspects of engineering as well as serve as a support figure who looks like them to increase their motivation and self-esteem in doing engineering. This SHPE mentoring role, thus, allowed Brian to provide Latin@ high school students with *apoyo* and *consejos*

that influential individuals similarly gave him when making the decision to pursue engineering at a four-year university.

He discussed how he felt as though he was constantly going back and forth across “different worlds” that never overlapped such as his hometown circle of friends and the university context. As the intermediary between both worlds, Brian saw himself as being completely social with his hometown friends who did not “fully understand [his] experiences as an engineering student” while offering them perspective on what he does to be successful at the university. He sees his behavior shifting at the university where he is “very academic” and mostly engages with peers about engineering coursework including homework and studying for exams. These reflections capture how while in pursuing the responsibility to inform others of his success as a Latin@ in STEM higher education, he is conscious of needing to manage his forms of engagement based on contexts, or the “different worlds” that he navigates as an engineering student.

Brian perceived his undergraduate mathematics success as leading to a “good career” that he defined as being anything in the STEM fields like engineering. It is important to consider how Brian’s connection between undergraduate STEM success and professional advancement align with *consejos* from his father and the Argentinian community college professor about an engineering major broadening his opportunities for social and financial mobility. This promise of economic gain as a future engineer brought Brian to view his mathematics success as a way of “helping [his] parents out with the economic problems” that they faced at home. Similar to Daniel’s aims of not disappointing his parents by graduating as an engineering major, Brian’s goal of applying his engineering degree to financially support his parents is an example of *familismo* in the

Latin@ culture. Thus, we see how even though Brian's parents were not entirely supportive of their children's academic endeavors, Brian's *familismo* drives his commitment in helping his parents overcome their financial issues through his STEM success. We can also see here how the intersectionality of Brian's mathematics experience was shaped by his class identity as one of the lower-class kids "living in apartments" in his hometown whose family was experiencing financial problems.

Furthermore, Brian discussed how his mathematics success was a way of showing that "we're [Latin@s] not stupid like how people think we are" and proving others wrong in thinking that he could not pursue a math-intensive major at a four-year institution. He described how although he has not been explicitly told that he cannot pursue mathematics or engineering as a Latin@, Brian recalled experiencing microaggressions of his ability when others were shocked or surprised to learn about him studying mathematics and engineering. In the following excerpt, Brian recalled a time when he was pulled over by a police officer in his hometown and how surprised the officer was in learning about his considerations of completing a major in mathematics at the community college.

'Cause his facial expression was like a shocked face and he kept asking me questions as soon as I mentioned that major... The fact that he just kept asking me questions about that subject kinda made me think that he was kinda a little bit shocked because most of the people over there... like where I live, you wouldn't think like someone else like a Hispanic person would be doing engineering in college. (Interview)

Here we see how the context of Brian's hometown shaped the discourses and thus the microaggressions that he had to navigate as a Latin@ studying mathematics. With narratives of Latin@s in his hometown not pursuing higher education and instead working full-time vocational jobs after high school, Brian reflected on how he interpreted



the police officer's shocked reaction as being shaped by these discourses of Latin@s living in the local community.

Brian similarly discussed how stereotype of Asian Americans "doing good at mathematics or the science majors" was dominant at the four-year university. He drew on this discourse to make meaning of Asian Americans' overrepresentation in the campus where the university's mathematics department and most of the science departments are located. In addition, he reflected on how this stereotype is taken up by students in making meaning of university STEM professors calling on Asian American students more often in the classroom. It is noteworthy how, in alignment with his previously-discussed view of STEM students' sameness at the university, Brian described how peers' surprised reactions of meeting a Latin@ STEM student was less intense in the university context. While peers would be more surprised to learn that a Latin@ student was pursuing engineering than an Asian American student, according to Brian, these peers "don't act as shocked as someone else" outside of the university like the police officer in his hometown. Thus, we see Brian's awareness of how contexts such as Brian's hometown and the four-year university shaped racial discourses of mathematics ability as well as the varying intensity of racial microaggressions that he encountered as an engineering student.

At the intersection of his gender and racial identities as a Latin@ man, Brian commented on how low academic and professional expectations of Latin@s are gendered as they stem from discourses specific to Latin@ men as opposed to Latin@ women. The following excerpt captures how Brian perceives Latin@ women as expected to perform well academically and attending a college or university more than Latin@ men.

Most of the workers, they are all male. The ones that work outside. The ones that cut the lawns, they're all male. So whenever you're gonna stereotype, you look at the guys and say guys do all of this. But like a Latina, they have a little bit more slack as in like people don't really think about it that way because whenever someone wants to insult someone, they're stereotyping with the male character, not the female. When you look at the female, it's like, "Oh, they're probably doing fine. They're going to school? Oh okay, that's totally acceptable."  
(Interview)

This gendered view of academic expectations among Latin@s brought Brian to make meaning of why "more women [are] attending college than males" and individuals assume that "outside stuff" will prevent Latin@ men from pursuing higher education. Brian went on to use his family's financial problems as an example of this "outside stuff" that can academically divert Latin@ men. Considering the responsibility that Brian feels in financially supporting his family through a future engineering career, this reflection captures how Brian's mathematics success is a gendered endeavor that aligns with the masculinized image of men as breadwinners in the Latin@ family unit.

Brian's identity as a Peruvian immigrant in the United States also shaped the intersectionality of his mathematics experience including the meaning of his academic success. In his mathematics autobiography, Brian commented on how he takes pride in his pursuits of an engineering major because he is "representing [the] people in [his] country" through his achievement. He described how in attending a four-year university to obtain a STEM degree, he is disproving discourses of a Latin@ immigrant becoming a "delinquent or a deviant person" like those that positioned immigrant peers as "troublemakers" in high school. Furthermore, Brian discussed how being a Latin@ immigrant in engineering motivates him in terms of feeling like he "needs to do better for [him]self... [and] not looked down upon" by others in the United States. Thus, we see here how Brian views his mathematics success as a way of challenged how racial

minorities and immigrants are positioned as less successful much in alignment with his community college professors' *apoyo* and *consejos* about increasing social mobility among Latin@s in the United States.

**Relational spaces of undergraduate mathematics classrooms.** A softspoken, elderly professor of eastern European descent led Brian's differential equations lectures. Most of the students in the lecture hall were taking notes, surfing the Internet on their laptops, or sleeping while the professor presented his lecture. Barely any students appeared to be sitting next to someone familiar during the lecture periods. A large number of students arrived a few minutes before the end of lecture to submit homework assignments. Instructionally, the professor regularly offered multiple representations of the content, alluded to real-life applications of the mathematics, and made connections between different topics presented in his lectures.

There were minimal teacher-student interactions and no student-student interactions during the lecture periods. The professor, for example, posed questions to the entire class such as classifying a mathematical object and seeking suggestions on how to construct a graphical representation. During these instances, the professor focused his eye contact mainly at the students sitting in the front rows of the lecture hall. These questions were typically followed by student silence bringing the professor to address his own questions throughout the lecture. Even during one observed instance when the professor opened the lecture to allow for students to raise questions about the material or the upcoming exam, silence filled the lecture hall and the professor proceeded to present a general case for different examples of mathematical systems discussed in the lecture.

A white graduate teaching assistant led the recitation sessions for this differential equations course. The primary focus of the recitation meetings is reviewing solutions for assigned homework and exams. Most of the students in the class appeared to be engaged with the recitation instruction by taking notes. Much of the teacher-student interactions consisted of the graduate teaching assistant asking students what strategy should be used to solve a problem and closed-form questions of understanding (e.g., “Any questions so far?”, “Do you all see why?”).

It is noteworthy how the teaching assistant carried out the instruction with a sense of vulnerability by frequently apologizing to the students. During one recitation observation, the teaching assistant apologized four times including statements such as “Sorry if you had a hard time following that” and “Sorry to have gone over a little bit.” This vulnerability as a teacher may have stemmed from perceiving himself as lacking the mathematical content knowledge for leading the recitation sessions. In fact, Brian informed me after an observation that the teaching assistant shared with the students that he had to recently teach himself differential equations because he had not previously taken such a course as a mathematics student. A white man sitting toward the front of the classroom regularly corrected the teaching assistant’s work leading to some of his whole-class apologies. The teaching assistant also positively acknowledged several of the white student’s contributions to solving problems through comments such as “I like the idea of guessing.”

Furthermore, it is important to note the disparity in the teacher assistant’s engagement with questions and volunteered solutions raised by different students in the class. When a southeastern Asian male asked if an exam problem could be solved using

synthetic division, the teaching assistant cautioned, “Positive numbers are not going to work,” and proceeded to show why the synthetic division procedure was not mathematically appropriate. When Brian asked if using the quadratic formula would work, the teaching assistant then skeptically asked, “Why would you do that?” Brian replied that he was “just asking” to which the teaching assistant responded with “no” and a smirk followed by showing why the quadratic formula did not work. Both students volunteered a strategy that the teaching assistant already knew was not appropriate for the problem, but only Brian received a skeptical question to his own question and a dismissive smirk following his contribution.

The teaching assistant similarly addressed two students’ questions related to the grading of the recent exam in different ways. When the only eastern Asian student in the class asked if his answer would be acceptable, the teaching assistant responded, “Yes, this is fine.” Earlier in the same recitation session, the following exchange was made between Brian and the teaching assistant:

**Brian:** Does he [the professor] give like half credit if we got part of it right?

**Teaching Assistant:** Like I said in the beginning, I’m only going over the questions that I am going to grade. So the question becomes what am *I* going to do when I grade it?

This response from the teaching assistant is important to consider for a number of reasons. First, it had a stronger intensity compared to the reply given to the eastern Asian student who also inquired about the exam grading approaches. It is also negative in nature considering how the teaching assistant, once again, did not directly answer Brian’s question, but rather corrected him on what he should be asking instead. The teaching assistant’s response also alluded to the fact that he already mentioned “in the beginning [of the recitation session]” that the exam problems that he was reviewing would be those

ones that he is grading. Although I do not have insight into the teaching assistant's intentions behind reminding Brian of his earlier remarks, it is important to note that Brian arrived 15 minutes late to the recitation session and did not get to hear the teaching assistant's remarks at the beginning of the class. Thus, the teaching assistant's response may or may not be a way to address Brian's late arrival to the recitation session.

A shift in Brian's participation in the recitation session before and after this exchange with the graduate teaching assistant was noted. Prior to this interaction, Brian volunteered the quadratic formula as possible strategy to an exam problem and helped the teaching assistant with setting up a  $2 \times 2$  matrix for a different problem. After the exchange, Brian sat with his head held up by his hands followed by resting his head on the desk, all while watching the teaching assistant lead the recitation without taking notes or offering any other contributions. When I followed up with Brian after this recitation session, he commented on having asked about the grading because the teaching assistant had previously mentioned that the professor grades "too harshly," but already knows that he is "not doing good" and will fail the course largely due to his commute never letting him arrive to classes on time. Brian's shift in his participation during recitation raises considerations on the extent to which the teaching assistant's interaction was a tipping point for Brian who had already informed the teaching assistant about his late arrivals to class.

Brian's second professor for differential equations in the spring term was a charismatic, elderly man of southeastern Asian descent. He structured his lectures using problem-posing instruction by first projecting a challenging word problem, providing students with related theorems and equations for solving it, and inviting students to

independently work on solving the problem using the provided information. The professor, for instance, made prompts such as “Can you do it?... Solve it and go all the way to the end” and “Try to combine them and see what you get.” Similar to Brian’s first differential equations professor, this professor generally limited his eye contact to students sitting in the first few rows of the lecture hall. Even though the professor encouraged the students to solve problems at their desks, there was no follow-up with asking students to share their solutions with a partner or the entire class. The professor instead proceeded to either solve the problem without any student input on the board or project a PowerPoint slide containing the solution. There was a stronger focus on students’ correct execution of mathematical procedures than on the meaning and applications of the mathematics. It seemed as though Brian spent most of his time writing notes related to the presented examples during lecture and less on the discussed theorems and derivations of given equations.

Unlike Brian’s first differential equations lecture, this professor regularly engaged in multiple back-and-forth interactions with individual students during each lecture period. Both the professor and students initiated these exchanges. Students, for example, asked clarifying questions about the content and offered explanations or a different strategy in response to each other’s questions. Much of these student-initiated exchanges in lecture were mainly coming from a white woman (sitting in the front row for all observations), a southeastern Asian man (sitting in the second row for all observations), and an eastern Asian man (sitting in the third row with his legs held up by the seats in front of him). Both men appeared to be the most vocal students in the classroom: the southeastern Asian man made four contributions during my first lecture observation and

the eastern Asian man asked five clarifying questions during my second set of observations. It is important to note how the professor welcomed, acknowledged, and took time in the lecture to address individual students' questions. When responding to one of the eastern Asian man's questions, the professor commented, "That's an interesting question. Let's try to figure that out." Such patterns of student participation in the lecture raise questions about who is taking up space in this classroom as well as to what extent this is gendered and racialized especially considering the more vocal students' mutual identifications with the professor as Asian men.

However, there were multiple instances when the professor communicated about making himself accessible to his students if they needed any academic support outside of class. Three southeastern Asian students (2 women and 1 man), an eastern Asian woman, and Brian approached the professor after the second lecture concluded. Brian later said that he approached the professor to double check how well he would have to do in the next exam to pass the course. Toward the end of my first lecture observation, the professor approached two white women sitting toward the front and asked them how they performed on the most recent exam. He then stated, "Please see me for office hours with any questions about the exam." When another white women expressed concern about a topic that several students appeared to have found challenging, the professor responded, "If anybody has questions about that, we can talk during office hours."

#### **4.5c Cross-Case Analysis of Mathematics Counter-Stories**

In looking across Daniel and Brian's counter-stories, there are three emergent themes across their experiences related to institutional, interpersonal, and ideological influences on their mathematics success. What cuts across these themes from the two



Latin@ men's mathematics success is the blending of academic and moral support likened to notions of *apoyo* and *consejos* that Latin@ children receive from family members to increase their academic self-esteem and motivate their perseverance in education. Along with detailing these similarities, this section documents the variation between the two Latin@ men's gendered and racialized experiences in relation to institutional, interpersonal, and ideological influences on their mathematics success.

First, Daniel and Brian's experiences capture how undergraduate mathematics classrooms operated as white institutional spaces that constructed racialized hierarchies of ability along which Latin@s were positioned lower than their white, Indian American, and Asian American classmates. Both men discussed how such racialized positioning resulted in managing risks associated with classroom participation (e.g., asking questions, volunteering answers) in ways to protect their status as mathematically able from teachers' and peers' negative judgments. While Daniel reflected on these racialized dynamics contributing to "closed off" opportunities from connecting with higher-status peers in undergraduate mathematics classrooms, Brian expressed feeling less racial judgments from peers who seemed to be in the "same position" as him and more judgments from university mathematics instructors who regularly invited whites and Asian American students to participate. Daniel and Brian, despite these differences in perceived classmate tensions, both acknowledged awareness of being underrepresented as Latin@s across the university's mathematics classrooms. Institutional spaces like the SHPE organization meetings and structured study group sessions, however, served as counter-spaces where the Latin@ men were able to connect with fellow Latin@ engineering students and support one another more readily than they could in

mathematics classrooms and other university STEM education contexts. Daniel and Brian characterized the peer relationships in counter-spaces like SHPE as providing one another with the *apoyo* (moral support) and *consejos* (personal narratives for advisement) that encouraged them to persevere and see themselves as successful Latin@ engineers. Thus, these experiences point to the importance of carving institutional spaces like SHPE across colleges and universities that provide Latin@s and other underrepresented groups in engineering and STEM at large with support in navigating as well as feeling a sense of belongingness in the racialized contexts of undergraduate STEM education.

Secondly, the Latin@ men reflected on the importance of building academically and emotionally supportive relationships with undergraduate mathematics teachers for their success. Daniel and Brian looked back on the influence of community college and university professors who established relational spaces in mathematics classrooms that welcomed student participation, prioritized mathematical understanding, and were characterized by positive and supportive teacher-student interactions. Furthermore, the two Latin@ men discussed how these influential STEM faculty members' support went beyond coursework assistance as they were also emotionally reaffirming of their mathematics ability to become engineers especially as Latin@s. Such *apoyo* and *consejos* from these supportive faculty members were often provided during office hour sessions, thus illustrating how these STEM educators extended their relational support beyond the context of the undergraduate classroom. Daniel and Brian, however, also acknowledged how opportunities for building such supportive relationships with undergraduate mathematics faculty were unfortunately far and few in between for them. While Daniel failed calculus I twice and was placed on academic probation before

meeting Benjamin largely responsible for his “metamorphosis” as a mathematics student, Brian experienced a challenging academic transition from the community college that led to him nearly failing his first university mathematics course taught by a professor and graduate teaching assistant largely disconnected from their students. Daniel and Brian’s reflections highlight the importance of mathematics faculty members building relational spaces in undergraduate STEM classrooms that increase opportunities for *apoyo* and *consejos* that the Latin@ men saw as largely contributing to their “turning points” in mathematics.

Lastly, Daniel and Brian’s counter-stories capture how racial, gendered, and other marginalizing discourses shaped their mathematics experiences and ways of making meaning of their mathematics success. Both men demonstrated a strong sense of *familismo* (loyalty and sense of responsibility to the Latin@ family unit) through their reflections of seeing their mathematics success as either a way to make parents proud (Daniel) or financially supporting the family (Brian). In alignment with the cultural narrative of men as the breadwinners in the Latin@ family unit, mathematics success thus came to represent a masculinized endeavor for Daniel and Brian that they perceived with a sense of familial responsibility, or as a *obligación* (moral imperative). Brian, in particular, expanded on how his mathematics success served as a way of challenging discourses of Latin@s as academically and professionally disadvantaged that he perceived to impact Latin@ men, a population largely underrepresented in STEM fields and higher education. However, it is important to note that with the exception of the *apoyo* and *consejos* from supportive mathematics faculty and SHPE peers, the two Latin@ men were left on their own by and large in navigating these marginalizing

discourses encountered institutionally (e.g., Latin@s' underrepresentation in STEM education) and interpersonally (e.g., microaggressions of mathematics ability). This, therefore, points to the importance of establishing mathematics classroom spaces and designing STEM support programs in higher education that provide Latin@s and other marginalized groups with support in challenging these discourses and thus broaden opportunities in seeing themselves as doers of mathematics and engineering (Yosso et al., 2009).

#### **4.6 Discussion and Implications**

Addressing the aforementioned calls for research, this study centered Latin@ students' voices and classroom experiences to obtain deeper understandings of their undergraduate mathematics success at intersections of race, gender, and other identities. This analytical focus on success departs from findings on Latin@s' STEM underachievement in the literature and thus unpacks these students' underexplored narratives and strategies of success in navigating racialized and gendered contexts of undergraduate STEM education including mathematics classrooms. By complementing Latin@ engineering students' reflections with observations in their undergraduate mathematics classrooms, this study also offers a methodological approach to obtain more in-depth, situated insights into marginalized students' mathematics experiences that advance our understandings from post-hoc analyses predominant in the literature on mathematics identities. Exploring the two Latin@ men's mathematics success as a phenomenon constantly negotiated with white and masculinized institutional spaces of undergraduate mathematics, therefore, illuminates ways of advancing change in STEM higher education to broaden academic and social support opportunities for Latin@s at

intersections of race, gender, and other identities. Detailing the intersectional variation between the two Latin@ men's mathematics experiences nuances our scholarly understandings and inclusive educational practices for the advancement of Latin@s' success in mathematics and STEM more broadly at the postsecondary level.

Findings from this study corroborate and respond to scholars' call for equity considerations in undergraduate mathematics education particularly beyond calculus (Rasmussen & Wawro, under review). Considering Daniel's struggles with passing first-semester calculus and Brian's mathematics success working with supportive calculus professors in community college, I argue that such mindfulness for issues of diversity and inclusion must be taken up across the calculus course sequence serving as a gatekeeper for STEM-intending majors (Chen, 2013; Rasmussen, et al., 2014). At the interpersonal level of analysis, Daniel and Brian's reflections on building relationships with undergraduate mathematics faculty also extend extant work's arguments on the importance of establishing relational spaces in classrooms beyond the K-12 mathematics context (Battey, 2013b; Battey et al., 2016). This, therefore, raises considerations of how principles of culturally responsive pedagogy and challenging status of mathematics ability in the K-12 teacher education translate to undergraduate mathematics classrooms in broadening participation in STEM among Latin@s and other marginalized groups across the P-16 school pipeline.

At the institutional level of analysis, this study pointed to the significance of STEM support programs and organizations like SHPE in serving as counter-spaces for Latin@s and other underrepresented groups to connect with peers and develop a sense of belongingness in their majors as well as the institution at large. Daniel and Brian both

discussed how working with fellow undergraduate engineering students was an integral strategy in their mathematics success. This challenges Treisman's (1992) claim of students of color as inherently unable to form such peer networks and highlights the role that undergraduate STEM support initiatives play in facilitating the formation of supportive peer networks as well as sustaining them.

Moreover, notions of *apoyo* and *consejos* commonly found in Latin@ parenting for children's educational advancement cut across the influential forms of support that these two Latin@ men received to persevere and be resilient as mathematics students. What is important to note about the *apoyo* and *consejos* from Daniel and Brian's family members, undergraduate mathematics teachers, and SHPE peers is that they were forms of educational encouragement grounded in challenging discourses of Latin@s and, more specifically, Latin@ men as academically and professionally disadvantaged including in STEM. Thus, this raises implications for carving space in mathematics classrooms and STEM support programs where Latin@s and other marginalized groups can receive both academic and social support to successfully navigate these discourses encountered institutionally and interpersonally in undergraduate STEM education (Patton, et al., 2007; Yosso et al., 2009).

## **Chapter 5: Conclusion**

Gender is an important dimension to explore in better understanding marginalized students' mathematics experiences to advance change in broadening participation and academic success among women, racial minorities, and other underrepresented populations in STEM. Significant advances have been made in conceptual and methodological explorations of gender in mathematics education research. However, as argued in the review of research on gender in Chapter 2, there remains analytical space in the literature that examines gender as a social construct allowing for the detailing of within-group variation of mathematics experiences and strategies for success among women and among men. Although more recent scholarship theorizes gender as a dimension of identity produced differently across individuals and social contexts (e.g., Barnes, 2000; Mendick, 2006; Walshaw, 2001), much of this work falls short of documenting how mathematics experiences are differentially gendered when attending to the intersections of gender with other dimensions of identity such as race including whiteness (Leyva, accepted). This dissertation, therefore, addresses such minimal understandings in the literature of marginalized student populations' intersectionality of mathematics experience and how this shapes their strategies in successfully navigating white, masculinized spaces of mathematics.

### **5.1 Findings and Significance**

Findings presented in this dissertation highlight the gendered and racialized complexities of doing mathematics that differentially impacted the experiences of historically marginalized women of color and Latin@ men pursuing math-intensive STEM majors at a large, predominantly white university. These are two student

populations whose perspectives and experiences in mathematics are underexplored in the literature (Joseph, accepted; Varley Gutiérrez et al., 2011). In alignment with the calls for future research in Chapter 2 on more holistic explorations of gendered mathematics experiences, the two phenomenological studies in Chapters 3 and 4 adopted a three-tiered analytical framework to document the institutional, interpersonal, and ideological influences on these two populations' experiences across the P-16 mathematics pipeline.

In Chapter 3, I reported findings from an intersectional analysis of two African American and two Latin@ women's counter-stories on how they made meaning of their mathematics experiences and negotiated STEM success at intersections of their gender and racial identities. This offered insight into similarities and differences of mathematics experience between women of the same gender/racial identity as well as the variation across the two gender/race intersections explored in the study. Similarly, I documented the variation in the gendered and racialized intersectionality of mathematics experience between two undergraduate Latin@ men studying engineering in Chapter 4. Such analyses, thus, depart from the extant literature's deficit narratives of underrepresentation and underachievement among women and Latin@s as entire groups in mathematics and STEM at large. They allowed for the foregrounding of the women of color's and Latin@ men's voices to learn about their strategies in negotiating their intersectional identities with notions of doing mathematics that mapped onto empowerment, resilience, and success in STEM.

The women of color's reflections in Chapter 3 captured their labor of managing how others perceived their academic ability through strategies such as sitting toward the front of mathematics classrooms and silencing their achievements. This was emotionally



exhausting for the African American and Latin@ women who found themselves at intersections of gendered and racial discourses of mathematics ability and thus often did not know which discourses were being adopted by others to judge them in and out of mathematics classrooms. At the intersection of their gender and racial identities, the Latin@ men framed their pursuits of mathematics success with a strong sense of *familismo* (Marin & Marin, 1991; Suarez-Orozco & Suarez-Orozco, 1995) such that it would promote their and their families' social mobility and thus direct challenge marginalizing discourses of Latin@s and, more specifically, Latin@ men as academically and professionally disadvantaged. These student populations, however, reflected on how engagement with institutional spaces (e.g., SHPE meetings) and interpersonal connections (e.g., Mr. Sosa in AP Calculus for Tracey, Benjamin in calculus I for Daniel) that provided them with support in managing these gendered and racialized discourses were far and few in between throughout their mathematics experiences. Therefore, these findings are significant as they illustrate marginalized populations' co-constructions of positive academic and social identities as being dynamically shaped by institutional contexts including mathematics classrooms and undergraduate STEM support programs – an advancement from post-hoc analyses of gendered and racialized mathematics experiences in the CRT and mathematics identity literature.

## **5.2 Implications for Research and Practice**

The review of research presented in Chapter 2 makes an argument for more nuanced conceptualizations of gender in future mathematics education research that examine its social construction at different intersections of identity (e.g., gender/race) as well as at different levels of influence (e.g., institutional, interpersonal, ideological). To

illustrate this need of scholarly explorations of gender, I raised the CRT literature as an example of a body of work that attends primarily to race in marginalized students' mathematics experiences and only considers intersectionality – one of its theoretical tenets – for the sampling of participants (e.g., African American men) with gender conceptualized as a female/male binary. CRT scholars acknowledge this absence of exploring the interplay of race, gender, and other dimensions of identities that shape students' experiences of oppression in mathematics (McGee & Martin, 2011; Stinson, 2008; Terry, 2010). Terry (2010), for example, called for a “broader theoretical discussion of constructed academic identities vis-à-vis Black masculinity” (p. 96) in better understanding the experiences of both African American women and African American men in managing different intersectional discourses (e.g., the image of the welfare queen among African American women, African American men as prisoners rather than college attendees).

Despite the CRT literature's drawbacks in its theorization of gender, I posit that its counter-storytelling methodology when complemented with intersectional conceptualizations of gender (not sex) will provide future researchers with more refined understandings of mathematics as a gendered and racialized experience for students across different marginalized groups. Furthermore, the adoption of ethnographic methodologies (e.g., classroom observations in Chapter 4) coupled with these intersectional analyses of gender as varying across contexts and individuals will provide future researchers with situated insights into how institutional spaces and interpersonal relationships make students' gender, race, and/or their intersections more salient at different times in their mathematics experiences.

In terms of educational practice, findings from this dissertation particularly in Chapters 3 and 4 point to the significance of K-12 and undergraduate mathematics teachers carving supportive relational spaces for marginalized student populations in their classrooms. The women of color's and Latin@ men's reflections and observed classroom experiences of managing risks of participation, higher-status students taking up space, and differential student treatment by teachers point to how gendered and racialized hierarchies of mathematics ability operate in undergraduate mathematics classrooms (Barnes, 2000; Boaler & Greeno, 2000; Esmonde, Brodie, Dookie, & 2009; Esmonde & Langer-Osuna, 2013; Martin, 2009). Mathematics teachers, therefore, play a major role in establishing classroom spaces for mathematics learning where gendered and racial discourses of mathematics ability are challenged and thus marginalized student populations have broadened access to academic and social support in being successful across the P-16 STEM education pipeline (Battey, 2013b; Battey et al., 2016). In light of the women of color's academic re-routings by first- or second-semester calculus and the Latin@ men's struggles in their first mathematics courses at the university, I argue that building such relational spaces is particularly important in undergraduate mathematics classrooms in much alignment with scholars' discussions of entry-level mathematics courses like calculus serving as a critical filter among STEM-intending majors (Chen, 2013; Rasmussen et al., 2014).

Findings from both studies in Chapters 3 and 4 also captured the struggles that the women of color and Latin@ men experienced in their respective transitions from high school or community college mathematics instruction to that offered at the university. Lauren and Brian, for example, discussed their challenges in making meaning of the

mathematics learned during lectures and how it brought them to “teach themselves” at home. This was a strategy for being successful in mathematics that Lauren and Brian did not have to pursue in high school or community college respectively because, as they shared, their former mathematics teachers prioritized student understanding and carved opportunities for support by addressing students’ questions. Thus, this raises considerations of how students including those identified as underachieving and underrepresented in postsecondary STEM education are prepared for and supported in adopting strategies for being successful with managing these pedagogical shifts in mathematics. Such preparations and support for marginalized students’ seamless transitions into engaging with the norms of mathematics pedagogy at four-year universities can better inform the nature of high school and community college mathematics teaching as well as be integrated into STEM student support programs’ academic services (e.g., coaching on effectively taking lecture notes and reading mathematics textbooks for sense making).

The women of color and Latin@ men in the two studies reflected on having minimal-to-no mathematics teachers in their K-12 and undergraduate education thus far who looked like them. However, both student populations commented on increased feelings of comfort, support, and motivation when taking mathematics classes with teachers who were also women, African American, or Latin@ and thus understood the gendered and racial discourses of mathematics success that impact their student experiences. If undergraduate mathematics coursework is serving as a critical filter and a bachelor’s degree in mathematics continues to be a content specialization requirement across K-12 mathematics teacher certification programs in the United States, I argue that

addressing these areas for increased inclusion and student support in undergraduate mathematics education will improve mathematics degree retention rates and thus address the issue of limited gender and racial diversity in the K-12 mathematics teaching force.

Moreover, findings from this dissertation corroborate those from extant work on marginalized student populations building peer networks as a strategy for receiving academic and social support for their mathematics success (Oppland-Cordell, 2014; Treisman, 1992; Walker, 2006). While the first-year college women of color in Chapter 3 discussed forming such networks in their home communities as high school students, the Latin@ men in Chapter 4 reflected on the role that STEM support programs like SHPE played in providing a space for *apoyo* (Auerbach, 2006) and *consejos* (Delgado-Gaitan, 1994) among fellow Latin@ undergraduate STEM students. It is important to note, however, that most of the women of color's ties to their STEM peer support networks were severed upon starting their first semesters at the university and thus were left with the burden of re-building such networks on their own as undergraduate STEM students. The Latin@ men, more advanced in their STEM coursework than the women of color in Chapter 3, shared how they had to take initiative in seeking opportunities like SHPE in order to find engineering peers who looked like them and were not often seen in their STEM lectures and recitations. These reflections on both student populations' success in building STEM peer networks, thus, challenge Treisman's (1992) argument about historically marginalized students of color's ability to build such networks on their own. At the same time, these findings highlight the important responsibility that higher education institutions especially predominantly white institutions have in facilitating the (re-)building of peer networks among marginalized student populations for academic and

social support in navigating the white, masculinized space of undergraduate STEM education.

### 5.3 Limitations

While findings from this dissertation inform future research and practice in mathematics education and higher education, limitations of the dissertation's review of research (Chapter 2) and two phenomenological studies (Chapters 3 and 4) must also be considered. First, not every scholarly work that focuses on issues of gender in mathematics education was included in the review of research presented in Chapter 2. The constraints adopted for the search and selection of literature with notable contributions may have limited my considerations of other scholarship (e.g., reviews and meta-analyses, peer-reviewed articles published in journals with lower impact factors). Thus, I caution readers that these constraints in the review were intended to present readers with a more focused analysis that made explicit the characteristics of the *achievement* and *participation* perspectives and thus must not be interpreted as viewing other works as not making meaningful contributions to the study of gender in mathematics education.

In addition, findings reported in Chapters 3 and 4 came from two phenomenological studies detailing the intersectionality of marginalized student populations' mathematics experiences mainly focused on intersections of gender and race. However, both studies captured how other dimensions of the women of color's and Latin@ men's identities including class, generational status, and immigration shaped the intersectionality of their mathematics experiences. Tracey and Brian, for example, alluded to the importance of their undergraduate mathematics success for increasing the

financial stability for their lower-class families. While both Rachael and Brian discussed the challenges of navigating higher education as first-generation college students, Brian in particular reflected on how these challenges intersected with recently immigrating to the United States and challenging discourses of Latin@ immigrants becoming full-time laborers rather than college students. Thus, the foregrounding of gender and race in my analyses across both studies limited my considerations of how other intersections of participants' social identities may have shaped their experiences and perspectives on mathematics success. The detailing of these other intersections' impact for different student populations, however, is an area for future research in mathematics education and STEM higher education.

Another limitation across both studies was the small size of their samples to address scholars' calls for more in-depth qualitative explorations of mathematics as a social experience among marginalized populations. In addition, findings from both studies were specific to the women of color's and Latin@ men's experiences as students at the same large, predominantly white university in the northeastern United States. This limitation in sample size and analytic focus on a single university context, therefore, are important to keep in mind when considering the findings across both phenomenological studies. It should be noted that generalizability across marginalized student groups and higher education institutions was not my investigative aim across both studies. Instead, I aimed to raise the voices of these women of color and Latin@ men largely absent in the literature to provide rich descriptions of their experiences of oppression and academic success as mathematics students. Findings from these studies, therefore, are intended to support audiences in mathematics education and higher education in seeking

*transferability* (Lincoln & Guba, 1985) for establishing more inclusive and supportive spaces in different P-16 mathematics classrooms and higher education institutions for women, African Americans, Latin@s, and various other intersectional subgroups marginalized in STEM (e.g., queer people of color) (Espinosa, 2011; Leyva, Massa, & Battey, in press).

Furthermore, the nature and amount of time spent with participants in each study were limited. Findings reported in Chapter 3 were based on data from mathematics autobiographies, interviews, and focus groups collected in one semester about the four women of color's mathematics experiences without any complementary insights from observations in their undergraduate mathematics classrooms and STEM support program spaces. Although I focused on a different gender/race intersection in Chapter 4, this limitation was addressed by layering the methodology from the previous study with ethnographic detailing of the instructional and relational spaces of Latin@ students' undergraduate mathematics classrooms over two academic semesters. These classroom observations provided me with insights into connections between participants' reflections and forms of engagement with content, instructors, and peers in mathematics classroom spaces. However, similar connections between the women of color's and Latin@ men's perspectives and their participation in undergraduate STEM support programs (e.g., SHPE in Chapter 4), a major influence in their engagement with opportunities of academic and social support, were unexplored. These limitations raise possibilities for deeper, longer-term inquiries to inform how the interconnectedness of support between mathematics classrooms and STEM support initiatives in higher education can further



advance academic success and retention among marginalized populations in STEM  
(Brown, 2002).

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## Appendix 1: Study 2 Focus Group Discussion Protocol

### Narrative #1: Taking Up Space in the College Mathematics Classroom

You are sitting in your college mathematics lecture and the professor asks the entire class the order of integration for a function expressed in terms of three variables ( $x$ ,  $y$ , and  $z$ ). Silence fills the entire lecture hall until you finally assert, “The order of integration does not matter.” The professor acknowledges your correct mathematical contribution and proceeds to write the integration problem on the blackboard. Students copy the professor’s blackboard notes into their notebooks. As the professor continues writing, you announce that a typo was made such that the “integration should be bounded between 0 and 1.” The rest of the class remains quiet with some classmates’ heads turned to you. The professor looks directly at you, positively acknowledges your input with a smile, and asks, “And with which letter would you like to start the integration?” You enthusiastically respond, “Let’s start with  $x$ !”

#### *Probing Questions:*

1. Do you see yourself doing something like this in your college mathematics lecture? Why or why not? What about in high school?
2. What if the majority of the students present in your college mathematics lecture were Latin@? Women?
3. What if the professor was Latin@? A woman?
4. Are there any individuals from your college mathematics lectures or recitations sessions who engage like this? Who are they? In what ways do they behave similarly and differently?
5. If you behave differently in college mathematics lectures and/or recitations, how do you behave? Why do you behave this way?

### Narrative #2: Racial and Gendered Stereotypes in the College Mathematics Classroom

You are sitting in your college mathematics lecture. Your professor is in the middle of taking the first derivative of a given function using the Quotient Rule in calculus. Thus far, your professor has only squared the expression in the denominator and prompts the entire lecture hall to provide him with the next step in taking the derivative. Silence thickens the lecture hall. You are absolutely certain that you know not just the next step, but all of the remaining steps to complete the entire process of taking the first derivative. Right before the professor turns to write the next step on the blackboard, you hastily volunteer all of these remaining steps, “You have to multiply the original expression in the denominator by the derivative of the expression in the numerator. Then, you must subtract the resulting expression from multiplying the numerator’s original expression by the derivative of the expression in the denominator.” The professor replies, “Woah! You’re jumping ahead a little bit now. Not all of us are as quick.”

During the recitation session for the same college mathematics course, the Teaching Assistant is stumped in finding an appropriate way to re-write a given rational function,  $f(x) = ax / b$ . You are pretty sure that re-writing the rational function as the product of two fractions – namely,  $f(x) = (x / 1) * (a / b)$  – will do the trick. As the Teaching Assistant continues staring at the original function in a perplexed manner at the blackboard, you raise the suggestion about re-writing the function equivalent as the product of two fractions. The Teaching Assistant turns to you and replies in a sarcastic, sing-song manner, “I don’t think so.” A few extra minutes are spent with the Teaching Assistant pondering about the appropriate mathematical course of action in solving the problem. However, it is to no avail and the Teaching Assistant announces that the problem solution will be posted on Sakai.

*Probing Questions* (will be asked following each partial narrative):

1. Were you ever in a situation like this in any of your college mathematics lectures or recitations? What happened?
2. If something like this has not necessarily happened to you, do you think it can happen? Have you seen it happen to others? Who and when? What happened?
3. To what extent do you see yourself doing what was described in the narrative? Why do you say that?
4. Can you think of anyone in your college mathematics lectures and recitations who may have responded similarly? Who are they? Do they do this often? Why do you think they are or are not able to respond this way?
5. Do you see yourself responding this way back in high school? Why or why not?

**Narrative #3:** Teacher-Student Relationships in College Mathematics Classrooms

You are sitting in your college mathematics recitation. The Teaching Assistant presents a triple integral in terms of  $x$ ,  $y$ , and  $z$  that was purposefully set up incorrectly and then asks the entire class what is wrong with the triple integral setup. You instantly notice that the given bounds of integration do not align with the sequence of differentials ( $dx$ ,  $dy$ , and  $dz$ ) in the Teaching Assistant’s problem setup. After you correctly identify this error in the triple integral setup, the Teaching Assistant references your contribution in other explanations during the recitation and cites your first name while doing it (e.g., “Exactly as [Insert student’s first name] said...”). The Teaching Assistant is someone with whom you frequently contact via e-mail with questions about assigned homework problems and grading-related questions. In addition, the Teaching Assistant frequently circulates the recitation classroom during partner and group problem solving exercises to support you and other students who may be struggling with the assigned tasks. All of these interactions bring you to have a close relationship with the Teaching Assistant so it is not a surprise that the Teaching Assistant acknowledges you on a first-name basis.

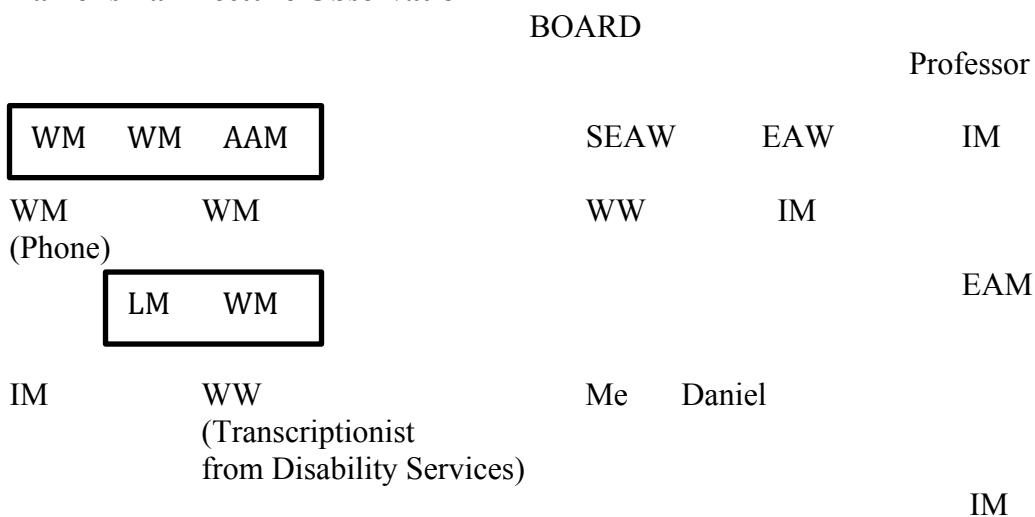
*Probing Questions:*

1. Have you had a similar type of relationship with a professor or Teaching Assistant leading your college mathematics lecture or recitation? With who was it? What was the nature of this relationship like? What allowed you to build this relationship with the professor or Teaching Assistant? Is there anything that you did? Is there anything that the professor or Teaching Assistant did?
2. If you have not established such relationships, what kinds of relationships have you previously established with professors or Teaching Assistants in your college mathematics courses? What prevents you from being able to establish closer relationships with professors or Teaching Assistants?
3. To what extent does your experience in establishing connections with your college mathematics professors or Teaching Assistant compare to that in high school? What was similar? What was different?
4. Do any individuals come to mind who establish relationships with professors or Teaching Assistants similar to that described in the narrative? Who? What do these students do that enable them to establish these relationships? Is there anything that the professors or Teaching Assistants do differently in connecting with these students?
5. Is there any connection to a professor or Teaching Assistant's race in establishing such relationships? What about gender?

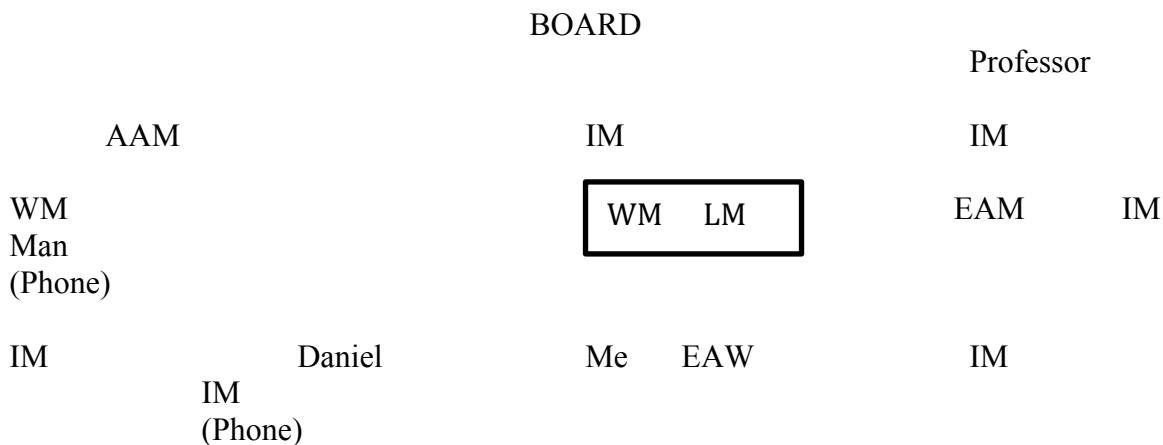
## Appendix 2: Study 2 Representative Mathematics Classroom Seating Charts

Note: The racial/gender acronym identifiers adopted in the seating charts are based on how professors and graduate teaching assistant may perceive students across these classroom spaces. Acronym identifiers grouped in boxes represent students who appear to know each other outside of the mathematics classes and are frequently interacting with each other during the observations.

### Daniel's Fall Lecture Observation #1



### Daniel's Fall Lecture Observation #2



#### Key

AAM = African American man  
AAW = African American woman

EAM = Eastern Asian man  
EAW = Eastern Asian woman

IM = Indian man  
IW = Indian woman

LM = Latin@ man  
LW = Latin@ woman

SEAM = Southeastern Asian man  
SEAW = Southeastern Asian woman

WM = white man  
WW = white woman



**Brian's Fall Recitation Observation**

BOARD

WM (Laptop)	WM	WW Brian	WM
WW WM (Phone)	WM	EAM	IM
	IW		IM
Me			WM

**Brian's Spring Lecture Observation #1 (Brian was absent.)**

BOARD

Professor Lectern

WM EAW	WM	WM AW (Older)	IM	WW	AM	WW WW	WW
EAW		IM	IW	IM	IM	EAM	EAW
WW EAW		AAW	IW		EAM	IW	
EAM Me	IW (Late)	LM (Late)	IW IW	WM	IM	WM	WW WW WM
WM (Late)				LM	IW		IM EAM (Late)
				EAW	EAW		EAM
						AAW	EAM

**Brian's Spring Lecture Observation #2**

BOARD				Professor Lectern
EAW	EAM	IM	WW EAM	EAW
WM	WM			
WW	WW	IM	EAM	Brian
				AAW
	IW	WW	IW	WM
	WM	IM	EAW	IM
				Me