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"I FEEL LIKE EVERYONE HAS ANXIETY WHEN IT COMES TO MATH": AN EXPLORATION OF STEREOTYPE THREAT AND ANXIETY FOR FIRST-YEAR MATHEMATICS STUDENTS IN HIGHER EDUCATION

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“I FEEL LIKE EVERYONE HAS ANXIETY WHEN IT COMES TO MATH”: AN EXPLORATION OF STEREOTYPE THREAT AND ANXIETY FOR FIRST-YEAR MATHEMATICS STUDENTS IN HIGHER EDUCATION

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

BY THE COMMITTEE CONSISTING OF

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Dedication

For Willow. My fellow hard-working, sharp-tongued, brilliant Brown Girl.

Abstract

Understanding of the relationship between anxiety and stereotype threat for students in first-year mathematics courses offers improvement for theoretical, methodological, and classroom practices surrounding the experiences of these constructs. This dissertation aimed to address the poor understanding of this relationship. Using a mixed methods participatory social-justice design (QUANT – QUAL), students' performance, anxiety, and stereotype threat data were analyzed through a Control-Value Theory (CVT) and Situated Expectancy-Value Theory (SEVT) lens. Design and analysis were also considered through the Quantitative Critical Race Theory (QuantCrit) methodological lens. This study showed that gender-, sexuality, and income-based stereotype threat positively predicted achievement anxiety, while race-based stereotype threat nearly did so. Additionally, students' anxiety did not predict their performance on the day data was collected, but their most recent math assessment score in their math course negatively predicted achievement anxiety during data collection. Some students identified connections of their emotions, identity, abilities, and changes during the assessment as additional information they wanted researchers to know. These results corroborate some research showing a correlation between achievement anxiety and stereotype threat and extend upon and challenge many previous studies which were not situated in real mathematics classrooms. Recommendations for classroom instructors include providing empowering help to students, providing threat nullification interventions without attempting to control students, and voting in elections to ensure that appropriate interventions remain options for educators. Challenges to future researchers include developing a situative component for CVT, reforming survey measures for stereotype threat, and increasing the use of open-response identity questions and other QuantCrit methodological considerations.

Table of Contents

Acknowledgements iv

Dedication viii

Abstract ix

Table of Contents x

Chapter 1: Introduction 1

Problem Statement 3

Purpose Statement 7

Relevant Theoretical and Conceptual Frameworks 8

Control Value Theory of Emotions 9

Relationships between CVT, Stereotype Threat, and Mathematics 10

Situated Expectancy-Value Theory 11

Methodology and Methodological Framework 13

The Centrality of Racism 14

Numbers are Not Neutral 15

Categories/Groups are Neither ‘Natural’ nor ‘Given’: For ‘Race’ Read ‘Racism 15

Voice and Insight: Data Cannot ‘Speak for Itself’ 16

Social Justice/Equity Orientation 17

Research Questions and Hypotheses 17

Significance of the Study 19

Definitions of Terms 20

Gender Identity 20

Race and Ethnicity: Distinct Constructs 21

First-Person Narrative 21

Positionality 22

Organization of Dissertation 23

Chapter 2: Review of the Literature 25

Stereotype Threat in the Broad Literature 25

Stereotype Threat in Undergraduate Mathematics Research 31

Academic Achievement Emotions 34

The Physiological Component 35

The Cognitive Component 37

The Motivational Component 40

The Expressive Component 41

The Affective Component 41

Stereotype Threat as Viewed Through the Control-Value Theory of Emotions 45

Research Gaps 46

In Chapter 3 48

Chapter 3: Methods 50

The Research Design 51

Participants and Sampling 53

Instruments 56

Stereotype Threat Environment 57

Math Performance 58

Self-Reported Stereotype Threat 59

Self-Reported Anxiety 64

Experience Survey 68

Identity Survey 69

Additional Items 70

The Research Procedures 70

Plans for Data Analysis 71

Quantitative Data Analysis 71

Qualitative Data Analysis 75

Integration of Quantitative and Qualitative Data 78

Summary 79

Chapter 4: Results 80

Quantitative Results 80

Descriptive Statistics 80

Research Question 1: To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety? 82

Research Question 2: To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)? 85

Preliminary Quantitative Analyses for Qualitative Sample Selection 87

Qualitative Results 91

Research Question 3: How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task? 91

Mixed Results 98

Research Question 4: How do the quantitative results on the relationship between anxiety and stereotype threat and qualitative results on perceived relationships between anxiety and stereotype threat combine to corroborate, extend, or challenge previous research and the typical classroom culture? 99

Summary 112

Chapter 5: Discussion 114

Summary of the Study 114

Interpretation of Findings 116

Research Question 1: To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety? 116

Research Question 2: To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)? 120

Research Question 3: How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task? 123

Research Question 4: How do the quantitative results on the relationship between anxiety and stereotype threat and the qualitative results on perceived relationships between anxiety and stereotype threat for less-represented groups combine to corroborate, extend, or challenge previous research and the typical classroom culture? 127

Implications and Recommendations 137

Practical Implications and Recommendations 137

Theoretical Implications and Recommendations 139

Methodological Implications and Recommendations 140

Limitations 141

Future Directions 146

Conclusion 147

References 149

Appendix A – Math Assessment 171

Appendix B – Modified SVS 174

Appendix C – Modified AAQ 177

Appendix D – Experience Survey 178

Appendix E – Identity Questions 179

Appendix F – Study Introduction Script 180

Appendix G – Informed Consent Handout 182

Appendix H – Debrief Document 184

Appendix I – Qualitative Codebook 185

Appendix J – Listwise Deletion Statistics 186

Appendix K – Sample Qualitative Analysis Profile 187

Appendix L – Triangulation Instructions 189

Appendix M – Complete Qualitative Codebook 191

Chapter 1: Introduction

Consider a student about to have their first interaction with university-level mathematics. This student is about to walk into a statistics, algebra, or calculus course. This class may be as part of their first semester of college (while adapting to a new and more independent life), concurrently as a high school student (attempting to blend in with the older students in the room), or perhaps they first need to take a pre-university-level refresher course. The student may have put off their general education math credit until later in their college career and ended up in a classroom full of first-year students. Try to imagine the way that this student feels enrolling in the course, walking to the first day of class, or sitting down for their first exam.

In your imagination of this student learning and taking tests in university-level math, do you imagine more enjoyment? Or perhaps more anxiety or like all hope was lost? Should we imagine that all of their feelings stem from the content they are learning and testing over, or are other experiences influencing their emotions as well? Imagine now that in addition to being in this first-year math course, their social identity does not match that of many (or any) of their classmates' identities. Imagine that they have heard through implicit and/or explicit messaging that people from their gender-identity, race/ethnicity, sexuality, or socioeconomic background are notoriously unintelligent, lazy, or otherwise unskilled in mathematics. Does this messaging affect the way they might interact with the material, their peers, or their instructor? Does it affect their learning and assessment?

In mathematics, certain populations are stereotyped based on their social identities to be less capable or more capable than average simply by their belongingness to a given group. For example, Asian students are stereotyped to be better than average at mathematics (Armenta, 2010; Aronson et al., 1999), while students who are Black or Latine (Armenta, 2010; Leyva et

al., 2020; Steele, 1997; Steele & Aronson, 1995), women (Burns & Friedman, 2012; Henschel et al., 2023; Leyva et al., 2020; Murphy et al., 2007; Steele, 1997), queer (Raymond, 2014; Voigt & Reinholz, 2020), or have a low income (Tine & Gotlieb, 2013) are stereotyped to be less capable than average in the domain of mathematics. These stereotypes are dangerous because "if one is not viewed as mathematical, there will always be a sense of inferiority that can be summoned, especially because the average citizen will not necessarily question the role of mathematics in society" (Gutierrez, 2018, p. 18). This point is illustrated by articles with nonsensical mathematical equations being interpreted as having higher quality and prestige by those who do not have degrees in science, technology, and mathematics (Eriksson, 2012). These results indicate a particular bias towards perceived mathematical ability in society in that a person who has high achievement in mathematics is considered smarter than those who do not. Therefore, in this dissertation, I report on a study about various forms of stereotype threat in mathematics as they connect to the related construct of achievement anxiety.

In Chapter 1 of this dissertation, I further outline the stereotypes for each of the social identity groups above. I define theoretical and methodological frameworks used to review the stereotype threat and anxiety literature in Chapter 2 and I introduce the research questions I aim to answer through the proposed study. In Chapter 3, I design a participatory social-justice mixed methods study. In Chapter 4, I describe that levels of gender-, race-, sexuality-, or income-based stereotype threats positively predict levels of achievement anxiety; that previously taken math assessments can predict achievement anxiety; and various themes about emotions and identity-related experiences from open-response data. Finally, I interpret results in Chapter 5, including explicit recommendations for challenging research and classroom norms; practical,

methodological, and theoretical implications of this research; and limitations and future directions from this study.

Problem Statement

In terms of gender-identity groups, skills stereotypically attributed to men make them better equipped for success in science, technology, engineering, and mathematics (STEM) – including skills in problem solving, inquisitiveness, and passion (or even obsession) for their chosen domain (Cribbs et al., 2015). Effects of gender stereotypes like this are illustrated by both men and women in higher education physical sciences classrooms being less likely to seek out women to study with, finding women knowledgeable, or identifying women as the best in the class, even when women are consistently outperforming men in those classrooms (Bloodhart et al., 2020). In fact, women who communicate their work in STEM are stereotyped to be "bitchy" (p.4), lack credibility, and are often judged on their appearance (McKinnon & O'Connell, 2020). Illustrating the impact of gender stereotypes in society, across a variety of degree types (from Associate's to Doctoral degrees), women attained less than 30% of all engineering degrees, less than 40% of all computer science degrees, just over 40% of mathematics and statistics degrees, and around 40% of earth, atmospheric, ocean, and physical sciences in 2019 (*Science and Engineering Indicators 2022*, 2022). Gender stereotypes about women in STEM may expand to include gay/bisexual men (Raymond, 2014) or gender-expansive individuals (Voigt & Reinholz, 2020) due to a perceived judgment about their identity as not masculine enough.

In terms of racial-identity groups, Black and Latine students are also subjected to stereotypes about their performance in academic achievement settings, though for different reasons. Instead of being domain-specific, these racial stereotypes tend to include academic performance more broadly (Schmader, 2010; Steele & Aronson, 1995). Black and Latine

students in mathematics classrooms feel stereotyped about behaving rudely, causing trouble, not trying/caring about their education, lacking intelligence, and lacking mathematical ability (Leyva et al., 2020). Black undergraduate students in engineering who feel stereotyped based on their race feel isolated within the domain of engineering, sometimes leading them to explore other options for their degree (Lira, 2022). In 2019, Latine graduates tended to have the highest percentages of degree attainment at the Associate's Degree level. Otherwise, Latine graduates make up less than 20% of engineering; earth, atmospheric, and ocean science; math and statistics; physical science; and agricultural science degrees (*Science and Engineering Indicators 2022*, 2022). Across all the engineering and science degrees considered by the National Science Foundation in 2019 – which includes social sciences and psychology – Black graduates made up less than 12% of all degree attainment. The educational debts of society towards Black students resulted in less than 8% of engineering; around 4% of agricultural science; around 12% of computer science; around 3% of earth, atmospheric, and ocean science; around 5% of mathematics and statistics; and less than 10% of physical science degrees attained (*Science and Engineering Indicators 2022*, 2022).

Additionally, Native American graduates made up around 1% of all engineering and science degree attainment in the same year (*Science and Engineering Indicators 2022*, 2022). Native American students are often aggregated into an "other" category or denoted by an asterisk to indicate why their data is not included (Shotton, 2013). Native American students who can persist through STEM degrees, like Engineering, may need to enact a concept called "survivance" – a combination of survival and resistance which "calls for adaptation and strategic accommodation" (p.150) to combat overt or covert racial discrimination by fellow students and

faculty (Smith, 2019). Taken together, race-based stereotypes are varied and based on academic experiences, in general, as opposed to being entirely math focused.

Income-based stereotypes are also present in academic settings, including math performance (Tine & Gotlieb, 2013). The stereotype that low-income individuals or families are lazy or lack intelligence (Durante & Fiske, 2017) may be one of the reasons why a sample of high school sophomores in 2002 had only 14% of those from low socioeconomic status (SES) attain up to a Bachelor's degree by 2012, while around 60% of those from high SES attained the same level of education in the same time frame ("Postsecondary Attainment: Differences by Socioeconomic Status," 2015).

Empirical research suggests that making gender-, sexuality-, race/ethnicity-, or income-based negative stereotypes salient result in lower performance quality (Armenta, 2010; Burns & Friedman, 2012; Chalabaev et al., 2012; Keller & Dauenheimer, 2003; Lesko & Corpus, 2006; Mangels et al., 2012; McGlone & Aronson, 2007; Raymond, 2014; Schmader, 2010; Steele & Aronson, 1995; Tine & Gotlieb, 2013; Totonchi et al., 2021); slower speed of performance (Steele & Aronson, 1995); increased vigilance and thinking about stereotypes and being judged for performance (Burns & Friedman, 2012; Murphy et al., 2007; Schmader & Johns, 2003; Steele & Aronson, 1995); increased effort or perceptions of effort cost (Aronson et al., 1999; Totonchi et al., 2021); decreased working memory capacity and other executive resources (Johns et al., 2008; Schmader & Johns, 2003; Tine & Gotlieb, 2013); increased anxiety or its suppression (Johns et al., 2008); and decreased self-esteem or expectations for success (Lesko & Corpus, 2006; Rosenthal et al., 2007); among other outcomes and experiences. These effects of stereotypes about a group on the person identifying with the group are called *stereotype threat effects*. The situational phenomenon, threat, or pressure felt by a person faced with judgment

based on stereotypes about a group to which they belong is called *stereotype threat* (Aronson et al., 1999; Spencer et al., 1999; Steele, 1997; Steele & Aronson, 1995). A few have defined stereotype threat specifically as a type of anxiety (Herts & Beilock, 2017; Lira, 2022; Totonchi et al., 2021) – that is, an emotion. Hertz and Beilock (2017) suggest that stereotype threat is a type of state anxiety, like test anxiety or math anxiety. A more recent publication defined stereotype threat as "the fear people experience when they are at risk of confirming a negative stereotype about their cultural group" (Archer et al., 2022, p. 93). These categorizations of stereotype threat as emotions are not common, particularly because of the mixed results when attempting to use anxiety as a mediator to performance under stereotype threat (Schmader & Johns, 2003).

Stereotype threat has been tied to anxiety both in working definitions of stereotype threat (Herts & Beilock, 2017; Lira, 2022; Totonchi et al., 2021) and in studies about the relationships between stereotype threat and anxiety or similar achievement emotions (Johns et al., 2008; Osborne, 2001; Schmader & Johns, 2003). It is reasonable to suspect a relationship between stereotype threat and anxiety since, like stereotype threat, those with high math anxiety tend to avoid mathematics, have lower mathematics performance, and struggle with working memory capacity in mathematics problems (Ashcraft, 2002; Herts & Beilock, 2017). In fact, a meta-analysis on math anxiety found that higher levels of math anxiety were correlated with a higher tendency toward believing gender-based stereotypes in mathematics and fewer mathematics courses taken in college (Hembree, 1990). Interestingly, results have been inconsistent in studies trying to explore the relationship between anxiety and stereotype threat. While some studies have shown a significant correlation between stereotype threat and anxiety (Aronson et al., 1999; Johns et al., 2008; Schmader & Johns, 2003; Spencer et al., 1999), others have found evidence of those experiencing stereotype threat suppressing anxiety (Johns et al., 2008) or not finding the

expected relationship between stereotype threat and anxiety (Keller & Dauenheimer, 2003; Schmader & Johns, 2003; Steele & Aronson, 1995). The inconsistent results from studies attempting to relate stereotype threat to anxiety creates a barrier to being able to fully address the pervasiveness of stereotype threat in both theory and practice, since it is a threat that – up until this point – we do not fully understand. This poor understanding of the relationship between stereotype threat and anxiety means that we cannot parse out when to address a cause of stereotype threat versus a cause of anxiety not associated with stereotype threat. Therefore, better explaining the relationship between stereotype threat and anxiety through additional research could mean that stereotype threat will not be veiled by anxiety, or vice versa.

Purpose Statement

The purpose of this dissertation is to explore the relationship between stereotype threat and state anxiety for students in first-year undergraduate mathematics courses. On one hand, categorizing stereotype threat as a type of state anxiety – a departure from how it is categorized in the seminal stereotype threat research (Steele & Aronson, 1995) – could serve to better determine and implement interventions against stereotype threat effects, considering the large amount of literature on anxiety in the mathematics classroom. On another hand, categorizing stereotype threat as an emotion (i.e., anxiety) may accidentally discount any distinctions it may have from other state anxieties, leading to inappropriate interpretations of future results. In this dissertation study, I will use a convergent mixed methods participatory social-justice design (QUANT – QUAL) to determine relationships between achievement anxiety and stereotype threat.

In the remainder of the introduction, I will outline the relevant theoretical, conceptual, and methodological frameworks for use in the remainder of the dissertation as well as operationally define some terms and set writing norms for the remaining chapters.

Relevant Theoretical and Conceptual Frameworks

Emotions are broad experiences, which are occurring in our mind all the time as reactions to the world around us (Pekrun, 2006). Our brain uses past experiences, current sensations inside the body, and context clues from outside the body to interpret each event as it occurs (Barrett, 2017). In educational settings, an instructor like me is not often focused on the cognition of a student's emotion (epistemic emotions). Instead, my focus is often on a student's experiences about their personal success or failure, rather, their achievement emotions (Pekrun & Linnenbrink-Garcia, 2012). In this section, I draw from the Control-Value Theory of emotions to define achievement emotions and their antecedents.

Achievement emotions may be defined in a three-dimensional classification based on their *valence* (positivity or negativity of the emotion), *activation* (their psychophysiological arousal, either activating or deactivating), and their *object focus* (regarding the activity as it happens, the prospective outcome, or the retrospective outcome; Pekrun, 2006; Pekrun et al., 2006, 2010). Some achievement emotions that have been commonly documented for students in higher education settings are enjoyment and pride (positive activating), relief (positive deactivating), anxiety and anger (negative activating), and boredom (negative deactivating; Pekrun, 2006; Pekrun et al., 2006, 2009, 2010; Pekrun & Linnenbrink-Garcia, 2012). Some achievement emotions are particularly salient for students in higher education mathematics classrooms. For example, math anxiety and testing anxiety have been widely researched in the quest to explain varying performance levels for students of similar ability (Ashcraft, 2002; Barroso & Ganley,

2021; Hembree, 1990; Lyons & Beilock, 2012; Pekrun et al., 2009; Schutz et al., 2013). One explanation for the differing emotional experiences between students lies with the Control-Value Theory of Emotions (Pekrun, 2006), which is summarized below.

Control Value Theory of Emotions

The *Control-Value Theory* (CVT) of emotions connects the object focus dimension of achievement emotions to certain appraisals made by the individual student to explain the experience of an emotion. Table 1, as found in Pekrun's (2006) article explaining CVT, summarizes the emotions experienced under certain object foci and appraisals. The emotions expected from a certain object focus, control appraisal, and value appraisal span the four quadrants created by the valence versus activation dimensions of Pekrun and colleagues' definition for emotions (Pekrun, 2006; Pekrun et al., 2002, 2006, 2009, 2010; Pekrun & Linnenbrink-Garcia, 2012).

Negative activating emotions – like anger, anxiety, frustration, and shame – enhance the use of superficial learning strategies and undermine the use of deep and meta-cognitive strategies (Pekrun et al., 2006). While waiting for feedback about their performance, the student who was trying to avoid failure and feels only a moderate level of control will experience anxiety. After receiving negative feedback, they will experience shame if they felt control over the situation, but anger if they felt that someone else (like their instructor) had control (Pekrun, 2006). Anxiety, a negative activating emotion, has been most connected to the construct of stereotype threat. Therefore, this emotion will be the focus of this dissertation.

Table 1

The Control-Value Theory from Pekrun (2006).

Object Focus	Value	Control	Emotion
Outcome/prospective	Positive (success)	High Medium Low	Anticipatory Joy Hope Hopelessness
	Negative (failure)	High Medium Low	Anticipatory relief Anxiety Hopelessness
Outcome/retrospective	Positive (success)	Irrelevant Self Other	Joy Pride Gratitude
	Negative (failure)	Irrelevant Self Other	Sadness Shame Anger
Activity	Positive Negative Positive/Negative None	High High Low High/Low	Enjoyment Anger Frustration Boredom

Relationships between CVT, Stereotype Threat, and Mathematics

Control-Value Theory is a valuable lens for viewing emotions in mathematics classrooms when we want to see why students feel a certain way during an activity, while they wait for feedback, and after they receive feedback, but CVT does not tell the whole story of students in mathematics. Measurements on emotions, competence beliefs, and value beliefs in children from varying socio-economic and cultural backgrounds revealed that CVT was experienced similarly for both boys and girls from Bavaria (Frenzel et al., 2007) – that is, the amount and locus of control as well as amount of value for a task led to the expected achievement emotions. The control and value that girls experienced, however, were markedly different than those of the boys

– with girls experiencing lower thoughts of competence and lower value for mathematics. This paralleled experiencing less enjoyment and pride along with more anxiety and hopelessness. As noted by the researchers in the study, stereotype threat for these girls in their mathematics course could be influencing their academic self-perceptions in math over the formal feedback they were receiving through their grades (Frenzel et al., 2007).

Although as noted previously Control-Value Theory appears to operate similarly between young Bavarian boys and girls, the diversity of the participants in this study does not indicate that CVT does so similarly between different gender identity, race/ethnicity groups, sexual identity, or income levels. In fact, much of the developmental work in CVT has been done in primarily European populations (Frenzel et al., 2007; Goetz et al., 2006; Pekrun, 2006; Raccanello et al., 2020). Even when CVT appears to similarly apply across varying populations, it does not explain differences in the motivational appraisals made by students – that is, the events that led up to a student appraising their control and value in a certain way. It is worthwhile, then, to view emotions and stereotype threat in mathematics through a lens that may explain these differences, because antecedents to the emotional trajectory of CVT may be what leads stereotype threatened students to experience achievement anxiety. I thus integrate CVT with Situated Expectancy-Value Theory, which is discussed next.

Situated Expectancy-Value Theory

According to Situated Expectancy-Value Theory (SEVT) students' motivational beliefs will be determined by their expectations for success (expectancy), the value they place on the task or success at the task, the cost of engaging with the task, their previous personal experiences, and the broader cultural context (Eccles & Wigfield, 1995, 2020; Rosenzweig et al., 2021). A crucial tenet of SEVT emphasizes that these motivational experiences do not exist

within a vacuum. For example, a student – who has their own previous experiences, culture, inner circle of people, and environment, shaping their expectancies and values – will be in a very personally unique position to make the decision to do a certain task. This means that they may make a decision that is different from a classmate even if their value, cost, and expectations for success are the same as their classmate's value, cost, and expectations for success. This student's performance, then, influences all of those surrounding factors, creating a new previous experience and potentially having an influence on their beliefs and behaviors or interpretation of future experiences (Eccles & Wigfield, 2020). SEVT adapts to the culture and previous experiences of students in a way that CVT cannot. SEVT informs this study, not only by implementing a cultural and situational consideration for students' lived experiences, but additionally tying into the motivational aspects of stereotype threat. In particular, previous research in stereotype threat has shown that it can be especially prevalent in stereotyped individuals who have a strong mathematical identity – namely that they expect to perform well in mathematical settings and that they value their success in mathematics.

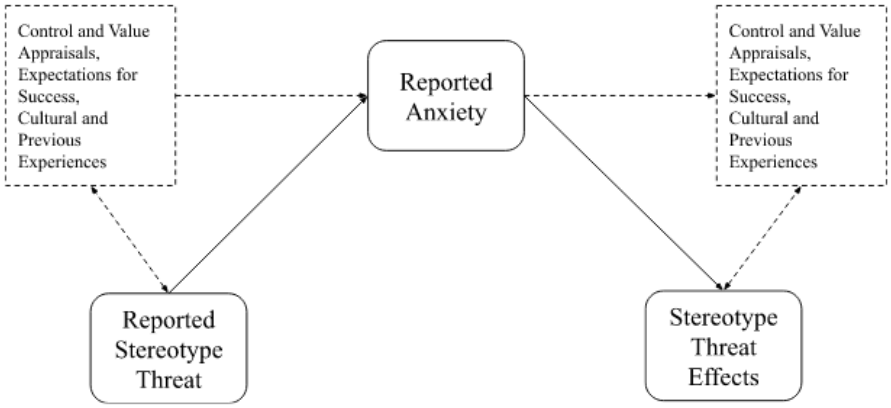
The theoretical lenses of CVT and SEVT may help us to understand what control and value leads a student to experience achievement anxiety and what other value appraisals may lead the student to engage with an activity – even when risking experiencing perceived stereotype threat.

In this dissertation, I will use CVT to interpret the quantitative data relating achievement anxiety (an output of CVT) to stereotype threat and will use the cultural and experiential components of SEVT to connect these quantitative results to open-response questions about students' emotions and experiences on a given math task in the study (see Figure 1). In addition to using CVT as a primary theoretical lens with the assistance of constructs defined through

SEVT, I will also employ a methodological lens for viewing the literature, designing the study, analyzing the data, and interpreting the results. I outline this methodological lens in the next section along with previewing the way which it may be used for the remaining chapters. In Chapter 2, I will more specifically outline the use of this lens in designing the study.

Figure 1

Conceptual Model of Correlations



Note. Conceptual model illustrating hypothesized correlations between constructs and the theoretical framework's relationship to those constructs. The dashed boxes represent the theoretical variables from CVT and SEVT while solid shapes represent variables from the study. In particular, Control and Value Appraisals are from CVT, while Expectations for Success and Cultural and Previous Experiences are from SEVT. The dashed lines represent the theoretical relationships between CVT, SEVT, and the variables in the study. Notice that each variable in the study has a dashed line running to and from the dashed boxes to indicate the iterative process of both CVT and SEVT frameworks. The solid lines represent the hypothesized predictions between constructs.

Methodology and Methodological Framework

Quantitative Critical Race Theory (QuantCrit[1]) is a methodological application (though not a pure subset of) Critical Race Theory (CRT). QuantCrit has five guiding principles for

[1] QuantCrit is one of many critical approaches to quantitative inquiry. Each approach is distinct in its tenets and best practices, so while QuantCrit can be compared to Critical Race Quantitative Intersectionality (CRQI; Covarrubias et al., 2018), Quantitative Critical Theory (Stage, 2007), Critical Quantitative Inquiry (Curley, 2019), Quantitative Criticalism (Tabron & Thomas, 2023), etc. Occasionally, "QuantCrit" is used as an umbrella term over many similar approaches, which are all valuable lenses. This study uses the specific tenets from QuantCrit and the suggested best practices from Gillborn and colleagues (2018).

researchers using quantitative data: (1) the centrality of racism, (2) numbers are not neutral, (3) categories/groups are neither 'natural' nor given: for 'race' read 'racism', (4) voice and insight: data cannot 'speak for itself', and (5) social justice/equity orientation (Garcia et al., 2018). The mixed methods study introduced in Chapter 3 – and reported and analyzed in Chapters 4 and 5 – will follow these tenets, as outlined in the following few sections.

The Centrality of Racism

Inspired by CRT, QuantCrit "recognizes that racism is a complex, fluid and changing characteristic of society that is not automatically nor obviously amenable to statistical inquiry" (Gillborn et al., 2018, p. 13). Therefore, researchers must be cognizant of the ways their quantitative research can be interpreted by others – as implicit biases, created by the centrality of racism in our society, mean that some people will intentionally read quantitative research with an eye for eugenics or other biases. In this dissertation, within the quantitative analysis, I identified the groups of students who are least represented within the sample as well as those who were or typically would be overly aggregated with other groups and qualitatively analyzed their quantitative data – creating a narrative of their experiences. Groups that may have otherwise been discounted as outliers have had their stories pulled to the forefront. Additionally, my hope in employing a mixed methods study is to give space for conventional quantitative data analysis in our field, but to also take a closer look at the data through stories told by the students in certain groups before concluding that any particular relationship has taken place. Taken together, this study aims to recognize the complexity and fluidity of racism within society by centering the experiences and voices of students who might otherwise be overshadowed by statistical inquiry alone.

Numbers are Not Neutral

Quantitative analyses are given a lot of privilege in society and are often assumed to be more objective than qualitative data. However, "QuantCrit exposes how quantitative data is often gathered and analyzed in ways that reflect the interests, assumptions, and perceptions of white elites" (Gillborn et al., 2018, p. 14). Stereotype threat originated as an alternative explanation to the deficit narratives created around 'performance deficits' of Black people and women in standardized testing and mathematics, respectively (Spencer et al., 1999; Steele & Aronson, 1995). From the beginning, then, stereotype threat research has acknowledged that numbers are not neutral and that researchers needed to look beyond the easiest, Eurocentric interpretations of quantitative results. In this dissertation study, I continue the path laid out for me by previous researchers in looking beyond the initial results of any statistical analysis and acknowledging that they are neither neutral nor objective. For example, I employ sensitivity analyses alongside the planned analysis to confirm that the methods for replacing data and the ambiguous results about normality do not change the interpretation of results. Additionally, I qualitatively analyze some of the quantitative results from the stereotype threat measure for students who are selected for qualitative analysis of their open-response questions and who provided their email address for member checking my analysis.

Categories/Groups are Neither 'Natural' nor 'Given': For 'Race' Read 'Racism

In quantitative research about different outcomes based on race, it is typical to ask participants about their racial identity, giving them some number of (finite) options. "QuantCrit interrogates the nature and consequences of the categories that are used within quantitative research . . . mainstream interpretations may erroneously impute 'race' as a cause in its own right, as if the minoritized group is inherently deficient somehow" (Gillborn et al., 2018, p. 15).

Because race is a social construct which is often conflated with ethnicity (DeCuir-Gunby & Schutz, 2014), a cultural identification, as discussed further later in this chapter, this dissertation study allowed self-identification by the students in the study using open-response questions for social identifiers. Open-response racial and ethnic identity reporting is a method encouraged by other QuantCrit researchers (Curley, 2019; Jang, 2018), in addition to being careful about using too many or too few categories in the data analysis later when aggregating certain groups (e.g., from a gender identity question, it usually makes sense to combine students who identify as woman and as female into one group, but context and research questions need to be deeply considered before aggregating groups which may have distinct experiences, like including trans men into a category with cis-gender men; Gillborn et al., 2018).

Voice and Insight: Data Cannot 'Speak for Itself'

We may sometimes see researchers write about 'emerging trends' or that the data 'speaks for itself', but this is not the case. Quantitative data does not speak, and trends do not emerge. In contrast, "data is open to numerous (and conflicting) interpretations and, therefore, QuantCrit assigns particular importance to the experiential knowledge of People of Color and other 'outsider' groups (including those marginalized by assumptions around class, gender, sexuality, and dis/ability) and seeks to foreground their insights, knowledge, and understandings to inform research, analyses, and critique" (Gillborn et al., 2018, p. 17). In this study, I let the students speak for themselves through the qualitative component, and by asking for their feedback on qualitative analyses on their quantitative data, which also helped me to interpret the overall quantitative data more correctly, and less through my own experiential lens, than I otherwise would have been able to do.

Social Justice/Equity Orientation

Quantitative research is often seen to be 'politically neutral' and superior to qualitative research in that numbers are seen as inherently truthful, without being swayed (Gillborn et al., 2018). In contrast, QuantCrit serves to "provide more insightful, sensitive, useful research that adds a quantitative dimension to anti-oppressive praxis" (Gillborn et al., 2018, p. 19). In this dissertation study, I drew from this tenet by integrating the quantitative data with qualitative data and contextual information about less prevalent groups within the population to interpret results towards change to classroom cultures. For example, mixing quantitative and qualitative data helps to center rather than risk aggregating across these students' experiences. Additionally, students may express, through the open response portion of the study, particular concerns about the origins of their stereotyped experiences or their anxiety which imply practical suggestions for mathematics instructors or policymakers in higher education. This dissertation study is about the relationship between stereotype threat and achievement anxiety for students. The focus is not only on an abstract relationship between two constructs, but the reality of the students in the study and ways to improve their university-level mathematics experiences.

Research Questions and Hypotheses

Given that the relationship between stereotype threat and achievement anxiety is poorly understood, the purpose of this study is to explore this relationship for first-year undergraduate mathematics students through the theoretical lenses of CVT and SEVT and the methodological tenets of QuantCrit. This study will employ a mixed-methods participatory social-justice design to explore this relationship between stereotype threat and achievement anxiety. Drawing from the previously mentioned empirical, theoretical, and methodological literature, the quantitative portion of the proposed study addresses the following research questions:

> (1) To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety?
> (2) To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)?

Using the quantitative data to assist with data selection for the qualitative portion of the study, this study addresses the following qualitative research question:

> (3) How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task?

In following guidance of Tashakkori and Creswell (2007) on describing how quantitative and qualitative strands of research will be mixed, integration of quantitative and qualitative data addresses the following mixed-methods research question:

> (4) How do the quantitative relationships between anxiety and stereotype threat and the qualitative results on perceived relationships between anxiety and stereotype threat for less-represented groups combine to corroborate, extend, or challenge previous research and the typical classroom culture?

I hypothesized that the quantitative results would show that achievement anxiety would have a predictive relationship with (1) each type of stereotype threat and (2) its performance effects, because I suspected that different reporting measures for anxiety in the past have resulted in the contention about anxiety's mediating or correlation relationship to stereotype threat (Johns et al., 2008; Schmader & Johns, 2003). Inconsistency in results about anxiety's relationship to stereotype threat may be due to varying (and inappropriate) measures for anxiety. Self-report anxiety measures are not interchangeable, and care should be taken to ensure that the chosen measure is appropriate to the research (Wall & Lee, 2021). Because I explored themes for students with certain social identities – including women, Black students, and gay students, as determined through quantitative analysis of the sample – and because I do not presume to know

what their experiences with stereotype threat or achievement anxiety might be, I do not have hypotheses about research questions 3 or 4.

Significance of the Study

From the initial stereotype threat studies, it was suspected that anxiety had a relationship to stereotype threat and its effects (Steele & Aronson, 1995). Some studies have shown a correlational relationship between stereotype threat and anxiety (Blascovich et al., 2001; Leker, 2017; Osborne, 2001; Spencer et al., 1999) while others have had mixed or no such results (Aronson et al., 1999; Johns et al., 2008; Keller & Dauenheimer, 2003; Raymond, 2014; Schmader & Johns, 2003; Steele & Aronson, 1995). Therefore, drawing across the extant literature, these inconsistent conclusions result in a poorly understood relationship between anxiety and stereotype threat. Exploring and better explaining this relationship would serve to improve student learning through educational practice recommendations for intervening in issues of stereotype threat, anxiety, or both. In this dissertation study, then, I begin to address this gap in understanding by carefully considering the instruments used to assess anxiety in previous studies and use that consideration to choose an appropriate measure for achievement anxiety to shed light on the discrepancy in correlational results from previous studies.

In addition to further exploring the relationship between anxiety and stereotype threat, this study serves to advance the field in research and teaching practice in other ways. The methodological framework of QuantCrit is relatively new within educational psychology spaces (Garcia et al., 2018; Gillborn et al., 2018), and using it alongside a conceptual framework which combines CVT and SEVT is a novel and distinct contribution to the field. Additionally, the QuantCrit lens allows for amplifying voices of students across several identities that are historically stereotyped and excluded in the mathematics domain and are typically removed as

outliers or lost in aggregation in quantitative analysis. In this study, I anticipated their voices giving rise to timely and needed recommendations in the classroom for addressing stereotype threat and anxiety which have yet to be considered.

Definitions of Terms

Following the lead of other critically focused researchers (Agger et al., 2022; Castillo & Gilborn, 2022) and following the advice of DeCuir-Gunby and Schutz (2014), I now define some terms that tend to be ambiguous throughout the literature and the way that I will choose to define and use them.

Gender Identity

Biological sex and gender are often conflated terms, and readers of research are meant to understand that people who are biologically female and those who identify as women are the same, even though most studies do not claim to take any measurements of biological sex as part of their data collection procedures. Gender identity is better considered as a social category (Frable, 1997). Throughout the remaining chapters, I will use the term *women* to mean people who identify as women and the term *men* to refer to people who identify as men. The only exceptions may be when a study used only the terms “male” and “female” to refer to their participants. If participants in a study identify as trans, nonbinary, genderfluid, or another identity not in the societal definition of the binary, I use the term “gender expansive” to refer to these identities. I note that students in the study may conflate the terms used for biological sex and gender identity, but I maintain their identification for themselves when qualitatively analyzing the data of an individual.

Race and Ethnicity: Distinct Constructs

As with biological sex and gender, race and ethnicity are also often conflated and confused with each other. *Ethnicity* is belongingness in a group based on shared national origin, ancestry, culture, language, or religion while *race* is a categorization of people based on a combination of their physical attributes and the associated power or privilege those attributes allow (DeCuir-Gunby & Schutz, 2014; Frable, 1997). In the remainder of this dissertation, I will use the term *race* to refer to the categorizations placed upon study participants. This may mean that words typically used for an ethnicity will be referred to as a race, due to the lack of true, open-response, self-identification by participants. I also choose to uplift those who have been historically excluded in the mathematics domain (such as Black, Indigenous, or Latine people or other People of Color) by strategically capitalizing their racial identities. Furthermore, I intentionally decapitalize white "to reject the standard grammatical norm" (Covarrubias et al., 2018, p. 19). Note that Latine is a gender-neutral term for Latino or Latina, which allows for noun declension (unlike Latinx, Latin@, and other previous variations of Latino/Latina) and Latin* is a newer inclusive alternative which acknowledges a wide variety of Spanish-speaking peoples and Latin Cultures such that the * can be replaced with -a, -o, -x, -e, Cultures, Peoples, etc. In referring to individuals from such a background, I will use either Latine or Latin* if I do not know the gender identity of the individual. When there are studies with Latine participants who identify themselves in a gendered way, I use the gendered terms accordingly, prioritizing self-identification of the individuals in the study.

First-Person Narrative

Throughout this dissertation, I choose the first-person active voice. The tenets of QuantCrit specify that research, no matter the method, cannot be done with a purely objective

eye (Garcia et al., 2018). In recognition that my positionality (see the next section for a full positionality statement) and unique identity in the research process may affect the analysis of literature, design of study, and analysis of results (Berger, 2015), I do not refer to myself in a distanced position – "the researcher" – nor do I answer these research questions passively – "the data will be collected from the participants." I acknowledge that this is different from the norm, which I reject.

Before discussing the organization of the remainder of the proposal, I embrace the advice of other Quantitative Critical Race Theorists (QuantCrits), and offer a statement of positionality (Covarrubias et al., 2018; Garcia et al., 2018; Gillborn et al., 2018), because critical self-reflexivity is "a necessary first step for the long journey of deracializing statistics" (Garcia et al., 2018, p. 154).

Positionality

As the sole researcher on this topic, I am a Native American (Seminole Nation of Oklahoma) woman with generalized anxiety, three postsecondary education degrees in mathematics, and am currently (mostly) able-bodied, though aware of the instability of my physical health due to Multiple Sclerosis. I grew up in Oklahoma, attended university for the first time in Kansas, then returned to Oklahoma to work on my Associate's, Bachelor's, and Master's degrees in succession. Throughout my primary and secondary education, I was generally proud of being able to pass (often very well) my mathematics courses with very little effort. When entering college the first time, I did not take any math courses as part of my fine arts program, but upon a return a few years later as a non-traditional student, I decided to major in the subject.

My previous positive experiences with mathematics courses did not mean that I was without struggle in my new college-level mathematics courses. I struggled with the content,

given a gap in math learning. I struggled with the environment, being one of very few women, very few People of Color, and very few non-traditional students in my classes. I struggled with some professors, who were implicit or explicit about their beliefs about women in mathematics or People of Color in academia. This struggle continued throughout each of three degrees in mathematics and continued when I was teaching faculty in a university-level mathematics department. At the beginning of my struggles with the content, when I found a new problem that was difficult to solve, I felt more shame and would sometimes avoid finishing the problem so that I wouldn't have to fail – citing a lack of time for the assignment. After a while, the struggle became normal, the emotions weren't as shameful as they were invigorating, and I no longer avoided the discomfort in a struggle to avoid failure. On the contrary, I try to embrace a good session of productive failure. This journey from avoidance of that struggle to embracing it was difficult, and I am grateful for the shift to productivity, though it can still be a struggle at times. Fighting against it is a conscious effort.

During my graduate studies, I began teaching mathematics. The struggles I had experienced, or were still experiencing, appeared common among my students as well. They may not have the same struggles or come from the same background and identities, but I recognized those who were in an avoidant stage, a productive stage, or a transition between them. I recognized when a student was struggling with more than content. This recognition has been a strength in my teaching, and I find it to be a strength to my research and to this study in that my first-hand experiences as a mathematics student and an instructor of mathematics students give me a complex viewpoint into stereotype threatening experiences.

Organization of Dissertation

In Chapter 2 of this dissertation, I will discuss a review of the stereotype threat literature through the definition of an achievement emotion and the components of Control-Value Theory. Through this literature review, I will justify the research questions which were stated earlier in Chapter 1. In Chapter 3, I will outline the design of a study which aims to answer these research questions. In Chapter 4, I will report the quantitative and qualitative results – rather, I describe that gender-, race-, sexuality-, and income-based stereotype threats, separately, predicted (or nearly predicted) levels of achievement anxiety; that previous exam performance nearly predicted levels of achievement anxiety; and that analysis of open-response data reveal themes regarding student's emotional experiences, identity-related experiences, or a belief that identity has nothing, or very little, to do with math performance. In Chapter 5, I interpret the quantitative results through a CVT, SEVT, and QuantCrit lens; interpret qualitative results with respect to relevant literature; mix quantitative and qualitative data and analysis to challenge research and classroom norms; report practical, theoretical, and methodological implications of this study; and discuss limitations and future directions.

Chapter 2: Review of the Literature

In Chapter 1, I described the need for untangling the relationship between emotions (particularly anxiety) and stereotype threat. In this literature review, I will begin by giving a brief history of stereotype threat in the extant literature, paying particular attention to its validity as a construct in the face of deficit narratives. Additionally, I will discuss some of the research in undergraduate mathematics in terms of stereotype threat. Finally, I define the components that make up an emotion, compare stereotype threat findings to these components, and describe some of the literature about anxiety, its components, its antecedents, and its relationship to stereotype threat.

Stereotype Threat in the Broad Literature

Stereotype threat can be defined as the sensation a person feels that they will fulfill a negative stereotype about a group to which they belong – a threat to performance or a pressure to succeed (Aronson et al., 1999; Spencer et al., 1999; Steele & Aronson, 1995). Furthermore, the stereotype needs to be relevant to their self-definition, and therefore, they identify strongly with the domain in which the activity and stereotype lives (Keller & Dauenheimer, 2003; Leker, 2017; Lesko & Corpus, 2006; Murphy et al., 2007; Steele, 1997; Totonchi et al., 2021). Some studies have also shown that the activity being performed needs to push them to the absolute brink of their abilities, or at least prove to be challenging, in that domain in order for stereotype threat to occur (Keller, 2002; Keller & Dauenheimer, 2003; Spencer et al., 1999). In this section, I will discuss a short history of stereotype threat research before discussing how it relates to the problem of untangling the relationship between stereotype threat and achievement anxiety.

Stereotype threat emerged as a possible explanation for ‘underperformance’ of Black students on standardized tests (Steele & Aronson, 1995). Previous analyses during the eugenics

movement for the difference between racial, ethnic, or gender identity groups in mathematics performance included biological or genetic explanations (Barroso & Ganley, 2021). These explanations, which centralize performance deficiencies of students, create a *deficit narrative*. Stringing together multiple deficit narratives allows researchers to form a *deficit perspective* and to continue interpreting their findings in this way (Adiredja, 2020). In research, "deficit approaches focus on finding and remediating, rather than acknowledging and sustaining individual differences as valuable parts of the human experience" (Cruz et al., 2021, p. 1). The biological or genetic explanation for performance differences, according to QuantCrit and a number of other perspectives (DeCuir-Gunby & Schutz, 2014), does not take into account the many possible mediating factors as to why a student does not perform at the level that a western European society deems appropriate. In fact, given that race is a social construct, a biological or genetic explanation is inaccurate since there are no known biological differences between people of different racial identities (DeCuir-Gunby & Schutz, 2014). In the interest of this literature review forming an *anti-deficit narrative* (Adiredja, 2020), I do not refer to the underperformance or overperformance of any groups of students, since this implies that the students are deficient and solely responsible for improving their performance. Additionally, referring to underperformance or overperformance risks implying a social comparison based on some reference identity group – which, for mathematics, usually means heterosexual, affluent, white, men. Instead, I might say that scores were higher or lower due to being in certain settings, or to borrow terminology from Van Dusen and colleagues (2022), refer to *society's educational debts* due to racism, sexism, classism, homophobia, etc. I acknowledge that referring to normed scores on an assessment does not entirely negate the ideas of "underperforming" or "overperforming", even if those words aren't used, per se. Because I live and work in a society that currently values

certain performance levels on math tests, however, I cannot entirely discount test scores in favor of other learning metrics.

The development of stereotype threat research paralleled a deeper understanding of society's educational debts and gave a non-biological explanation for the difference in academic performance scores in different settings. That is, stereotype threat gives a *race-reimaged* perspective to math performance research, which had previously been viewed through what DeCuir-Gunby and Schutz (2014) refer to as a *race-focused* perspective. Race-reimaged perspectives in research are those which take a construct that has been conceptualized based on a dominant or reference group (usually a Eurocentric one) and reimages it to accurately capture the experiences from students who are in more excluded or minoritized social identities (DeCuir-Gunby & Schutz, 2014). Stereotype threat research reflects a race-reimaged perspective on math performance research by finding appropriate (and more accurate) explanations of math performance differences between identity groups based on situative aspects. One such setting that appears to induce differing math scores for students of certain social identities involves students being told that their performance will be used diagnostically – to diagnose intelligence or math ability (Steele & Aronson, 1995). If students performed differently due solely to their biological sex or genetic markers in their ancestry, then groups of biologically female students would consistently perform worse than biologically male students, regardless of the setting. Furthermore, students of European or Asian backgrounds would always perform better than those with other ancestries.

Contrasting these explanations in the seminal studies on stereotype threat, however, studies with Black and white undergraduates from Stanford University showed that diagnostically worded instructions led to a disparity in scores and speed between these two

groups than if the participants were instead told that the assessment would be concerned with solving problems or were told to view the assessment as a challenge (Steele & Aronson, 1995). In fact, disparity in scores can also be seen between white men in a similar setting doing a mathematics assessment if they think their performance will be compared to the performance of Asian men, particularly if the white men have a high mathematics identification (Aronson et al., 1999), consistent with the idea that stereotype threatening conditions lead to worse performance (Steele, 1997), worse learning (Mangels et al., 2012), and a higher likelihood of discounting the value of the assessment (Lesko & Corpus, 2006) when domain identification is high. If the lack of evidence for biological differences were not enough, these results further illustrate that genetic markers do not cause these performance disparities.

Stereotype threatening conditions may also lead to differing performance for women in the mathematics domain. In one study, for example, women in a stereotype threat condition had lower test results than those who were told that the test did not show performance disparities by gender (Spencer et al., 1999). In fact, when an explicit stereotype threat condition was removed – comparing the settings between not mentioning gender disparities to mentioning that the assessment had no gender disparities – women in the no-gender difference setting had equivalent scores to men in the same setting (Spencer et al., 1999). This finding suggests that a gender *nullification condition* – one that both addresses that society assumes gender differences in mathematics performance and states that the current assessment does not show these differences – can also nullify the performance effects of stereotype threat.

Creating a setting for stereotype threat versus control settings may appear to be easy: tell a student that you are about to judge their performance based on their gender identity, race, sexuality, or income level, and they should feel stereotyped. Some studies have been nearly this

blatant with their experimental conditions by telling their participants in the stereotype threat condition that the test they are about to take has shown differences between groups (gender, race, etc.) – some stating which group performs better (Aronson et al., 1999; Keller, 2002) and others leaving it to the previous knowledge about stereotypes of the participants as to which would perform better (Armenta, 2010; Chalabaev et al., 2012; Johns et al., 2008; Keller & Dauenheimer, 2003; Lesko & Corpus, 2006; Mangels et al., 2012; Spencer et al., 1999; Tine & Gotlieb, 2013). These *explicit manipulations of stereotype threat* might look something like giving those in the stereotype threat condition a description for their task which says, "Understanding possible differences in testing methods is crucial as it has been claimed that these types of tests measure individual's true intellectual ability, which historically have shown differences based on ethnic heritage" (Armenta, 2010, p. 95). The contrast to this condition might be a neutral description which does not mention stereotypes (Armenta, 2010; Johns et al., 2008; Keller, 2002; Steele & Aronson, 1995) or one which nullifies the stereotypes by mentioning the stereotypes and that this task does not show differences between groups (Chalabaev et al., 2012; Keller & Dauenheimer, 2003; Mangels et al., 2012; Spencer et al., 1999).

Explicit manipulations of stereotype threat are not necessary for stereotype threat to be induced. Some manipulations, which I refer to as *moderate manipulations of stereotype threat*, do not bring up a stereotyped group in the task instructions or description, but will manipulate the domain being studied. An example of moderate manipulations of stereotype threat might be telling the participants that you are assessing intelligence or math ability in the stereotype threat condition and something like problem solving in the control or non-threat condition (Burns & Friedman, 2012; Chalabaev et al., 2012; Davis et al., 2006; Schmader & Johns, 2003; Steele &

Aronson, 1995). Other manipulations are even more subtle or environmental. Some examples of *subtle manipulations of stereotype threat* are giving a task with letters missing from words, asking the participant to fill in the letters to make a word, with one possible word associated with some kind of stereotype (Steele & Aronson, 1995); viewing a short comic or video ad which brings forth the stereotyped identity (Murphy et al., 2007; Raymond, 2014); priming gender identity by asking them to "list three reasons why one might prefer living in a coed floor in a dormitory" (McGlone & Aronson, 2006, p. 489); altering the number of same-group members in the vicinity (Ben-Zeev et al., 2005); or saying nothing at all (as compared to a stereotype nullification condition; Ben-Zeev et al., 2005; Spencer et al., 1999). The activation of stereotype threat can be explicit, subtle, or somewhere in between, with similar performance outcomes comparing the threatened group versus the non-threatened or threat-nullified groups.

These examples of varying stereotype threat manipulations show an ethical methodological concern with conducting stereotype threat research. The seminal researchers in stereotype threat suspected the effects of stereotype threat and needed an experimental condition versus a control in a laboratory setting. Since then, studies have given a variety of manipulations in the lab or the classroom and have repeatedly produced the performance effects of stereotype threat in mathematics for certain social identities. Since stereotype threat manipulations can affect long-term learning (Mangels et al., 2012), newer studies should evolve to not manipulate stereotype threat in their participants, now that we know it exists without additional manipulation. The study in this dissertation does not include any of these manipulations on stereotype threat. As an acknowledgement that stereotype threat exists without any additional assistance, a math assessment will be given to induce any already-existing stereotype threat and it will then be measured.

Most stereotype threat studies in the past have not been in a classroom setting, but a more controlled, quasi-experimental environment (Aronson et al., 1999; Ben-Zeev et al., 2005; Blascovich et al., 2001; Johns et al., 2008; Mangels et al., 2012; Murphy et al., 2007; Raymond, 2014; Schmader & Johns, 2003). Admittedly, some research questions cannot be answered in the classroom setting. For example, those which involve expensive lab equipment (Blascovich et al., 2001; Mangels et al., 2012) or those which might take up a lot of time. If an experimental design is necessary in a study on the effects of stereotype threat, the stereotype threat condition should look subtle, at most, and contrast a threat-nullification condition, as women in threat-nullification settings have shown decreased anxiety (Spencer et al., 1999). Drawing from the relative above-mentioned gap in the literature coupled with the benefits of prioritizing ecological validity, this dissertation study is thus conducted in a classroom setting (Shadish et al., 2002).

Taken together, research on stereotype threat originated with psychology, and many of the studies done within the domain of mathematics at the undergraduate level recruited participants from introductory psychology or other non-mathematics courses and took place in experimental or quasi-experimental lab settings (Armenta, 2010; Aronson et al., 1999; Ben-Zeev et al., 2005; Carr & Steele, 2009; Davis et al., 2006; Kiefer & Sekaquaptewa, 2007; McGlone & Aronson, 2006; Rosenthal et al., 2007; Schmader & Johns, 2003; Spencer et al., 1999; Tine & Gotlieb, 2013). This study is instead conducted in a classroom setting – that is, from students attending their own mathematics course surrounded by their day-to-day classmates. In the following section, I review some of the literature about stereotype threat in the mathematics domain that is more targeted towards first-year mathematics undergraduate students.

Stereotype Threat in Undergraduate Mathematics Research

Some studies on stereotype threat have been conducted in the population of first-year mathematics undergraduates and give a more particular insight to their experiences than in the more broadly sampled studies from psychology courses or university-wide sampling. For instance, one study across numerous institutions asked students in what they called P2C2 courses (precalculus to Calculus 2) how their identity may play a role in their experiences – particularly that of stereotype threatening experiences – in their current math course, revealing a few themes (McGrane, 2022). First, Asian or Asian American students may be expected to experience a stereotype boost (i.e., knowing that your identity matches one which is positively stereotyped can result in positive outcomes, such as a boost in performance; Armenta, 2010) from the society-held positive stereotypes about these students and their mathematics performance; however, the Asian-identifying students in this study felt such a pressure to succeed that they reduced help-seeking activities like asking friends, tutors, or instructors for help when they struggled (McGrane, 2022). This experience contrasts with that of the Black- and African American-identifying students in the same study who were underrepresented in their mathematics courses, inducing a sense of isolation and that they could not ask for help from friends, tutors, or instructors. Both populations felt a pressure to succeed – Asian students needing to maintain the race-based stereotype about their math performance, and Black or African American students needing to disprove the race-based stereotype about their math performance. While women in this study were not necessarily underrepresented in their mathematics course, they also felt a pressure to succeed and act as role models to other women while simultaneously being actively excluded, talked over, or talked down to by men during class, even when these women were more knowledgeable and were helping other students with the work (McGrane, 2022). The students in McGrane's study (2022) experienced pressure from others based on their identity,

affecting their performance and emotions. The results of this study also support the importance of conducting research in actual mathematics environments and classrooms to support realistic results, since the students had classroom-specific experiences that may not come to mind in a laboratory setting.

As a contrast to the design of many stereotype threat studies, Good and colleagues (2008) gave students in the last course in a Calculus sequence a practice test for an upcoming exam, which had questions from the Graduate Record Exam (GRE) Math subject test during a day of their class. The students received either a moderate stereotype threat manipulation or a stereotype-nullification condition on written instructions. The men and women in this study had no differences in their course grades, but men under moderate stereotype threat and women under stereotype-nullification answered more questions over the condition of stereotype-nullification. At the same time, all students in the stereotype-nullification condition performed more accurately than the moderate threat condition. Additionally, men were more confident than women, though women in the stereotype-nullification condition outperformed all other groups (Good et al., 2008). In a replication of this study, Benjamin (2020) did not see the same results, and instead saw that the only predictor of performance was a student's sense of belonging. Good and colleagues (2008) and Benjamin (2020) conducted studies typically designed in laboratory conditions and brought them into the higher education mathematics classroom, one study confirming results found in experimental conditions. Threat nullification conditions improve the performance for women at risk of gender-based stereotype threat. The study from Benjamin (2020), however, did not show this result. These conflicting results might show some of the dangers of bringing educational research out of laboratories and into classrooms, but more importantly indicate the importance of defining the research setting (i.e., what kind of classroom,

in what subject, at what kind of school, experiencing what political climate?) and real-life complexities (such as other constructs that would not be introduced or considered in a laboratory, and therefore might render the laboratory results less useful).

Taken together, this brief look into the state of stereotype threat in undergraduate mathematics courses suggests that stereotype threat is not always what it seems at the surface of quantitative results. Mixed methodologies, contextual considerations, and replications across populations should be considered, in addition to factors related to stereotype threat beyond confidence and performance. In particular, anxiety – the construct of interest in this dissertation study – is frequently studied as a potential correlate or mediator between stereotype threat and performance; it is a construct of interest in the current study because of some inconsistent results in the literature – some showing a relationship between stereotype threat and achievement anxiety and others showing no such relationship. Before I discuss anxiety, I will introduce the components of an emotion, which subsumes anxiety, and their relationships to the construct of stereotype threat. I will then discuss anxiety's components and antecedents.

Academic Achievement Emotions

Emotions have also been researched and defined in several ways. For this literature review, I adopt a definition of emotions from Pekrun (2006), who proposes that *emotions* are processes of affective, cognitive, motivational, expressive, and peripheral physiological subsystems. That is, each individual emotion has an affective component (the feelings themselves), a cognitive component (how the feelings manifest in rumination), a motivational component (whether, and how, a person experiencing this emotion approaches or avoids the situation), an expressive component (how the emotion manifests on their face, body language, or instinctive reactions), and a physiological component (changes in their vital signs, like heart

rate). Further, *achievement emotions* are those which are tied to achievement activities, like learning in a classroom or taking a test. These might be momentary and fleeting – a *state emotion* – or recurring and difficult to change – a *trait emotion* (Pekrun, 2006). Emotions may be categorized based on a two-dimensional plane. One dimension is the emotion's *valence* – how positive or negative the emotion is. The other dimension is its *activation* – its level of psychophysiological arousal, either activating or deactivating (Pekrun & Linnenbrink-Garcia, 2012). If stereotype threat sometimes behaves as an emotion, perhaps a type of state anxiety as some researchers claim, then this behavior is likely negative activating (like other types of anxiety or dejection emotions; Keller & Dauenheimer, 2003) and includes physiological, cognitive, motivational, expressive, and affective components. In the following sections, I discuss each component of an emotion and how they might relate to stereotype threat.

The Physiological Component

If stereotype threat has a physiological component, then it would increase arousal, increase heart rate, affect breathing, or have some other physically measurable reaction to being under threat. Ben-Zeev and colleagues (2005) offer some glimpse into the interactions between stereotype threat and arousal. They discovered that higher scores occurred for women under a stereotype threat condition (who were expecting to take a math test) on an easy (non-math) task than on a difficult (non-math) task. This result might be obvious – we often expect higher scores on easy tasks compared to difficult tasks – but they also found that there were higher scores on these easy tasks for women in the stereotype threat condition than the women in the non-threat condition alongside lower scores on the difficult task for women in the stereotype threat condition than all students in the non-threat condition. The women's heightened arousal due to

stereotype threat may have been high enough to enhance performance until the difficulty of the task interfered with that enhancement (Ben-Zeev et al., 2005).

African American men showed more explicit physiological reactions to stereotype threat in a study of men (both African American and European American) taking a verbal ability test (Blascovich et al., 2001). The high stereotype threat condition was a moderate manipulation, with a European American man saying his team from Stanford was doing a study on the biases in testing. The low stereotype threat condition was, instead, an African American man saying his team from Tulane, Howard, and the University of Michigan were working to create an unbiased test. In addition to the high stereotype threat condition inducing worse performance scores for the African American men, this race-based stereotype threat also increased African American men's mean arterial blood pressure. This reaction was not seen for the European American men in the study, or the African American men subjected only to low stereotype threat (Blascovich et al., 2001).

Subtle situational cues on women in STEM can also induce a threatening experience, resulting in physiological effects (Murphy et al., 2007). Students were asked to view an advertisement for a summer leadership conference with either an equal ratio of men to women in the ad or a larger ratio of men to women. The ad that featured the unbalanced ratio of men to women resulted in women viewers experiencing decreased cardiac interbeat intervals (a sign of increased heart rate), increased skin conductance, and sympathetic activation of the cardiovascular system compared to women who watched a gender-balanced video ad and compared to men watching either ad. This study showed that merely watching a video where women are underrepresented in a setting can create physiological reactions in women in addition to heightened cognitive vigilance, decreased feelings of belongingness, and a decrease in desire

to participate in that setting (Murphy et al., 2007). This study did not include a mathematics test, so it is difficult to say that the results would be the same in a math performance setting, but it does indicate that women in STEM are physiologically affected by same-group representation levels. I also take note that the design of this study acknowledges that data cannot 'speak for itself' (a tenet of QuantCrit; Gillborn et al., 2018) by including additional questions about related constructs – foregrounding the experiential knowledge of the women in the study when selecting analysis procedures and interpreting findings (Murphy et al., 2007). While they were successful in one tenet of QuantCrit, they also could have improved their design in another – since groups are neither 'natural' nor 'given', their focus on only two gender identities could have expanded to include a variety of gender identities. This design consideration would allow a clearer picture of the effect of stereotype threat on certain social identities.

Taken together, if stereotype threat has a physiological component, it would be characterized as experiencing increased arousal and skin conductance; decreased cardiac interbeat intervals; increased mean arterial blood pressure; and sympathetic activation of the cardiovascular system. Rather, stereotype threat produces similar peripheral physiological activation as the emotion of anxiety (Pekrun, 2006). Similarities in physiological effects could indicate either that stereotype threat is closely related to a state anxiety or that it induces a state anxiety, producing a similar physiological component.

The Cognitive Component

A cognitive component for stereotype threat would concern ruminating in such a way that disrupts regulation and affects learning (Mangels et al., 2012). Rumination effects may occur in a few ways, including the higher activation of cognition about stereotypes (Burns & Friedman, 2012; Steele & Aronson, 1995), about performance (Steele & Aronson, 1995), or about

judgments by the researcher (Schmader & Johns, 2003). Additionally, the cognitive component for stereotype threat may increase vigilance to details about the task or the student's surroundings as in the study from Murphy and colleagues (2007), which also showed many physiological effects of stereotype threat. Experiencing vigilance alongside those physiological effects are not entirely surprising in a threatened state.

Although perhaps surprising, increased arousal from stereotype threat may be misattributed to counter the performance effects of stereotype threat (Ben-Zeev et al., 2005). In the case of Ben-Zeev and colleagues' (2005) study, women were told that they'd be subjected to a subliminal noise which may cause arousal, nervousness, and increased heart rate. Those told this while in a stereotype threat condition were more likely to attribute any nervousness they felt to the subliminal noise and did not show a decreased performance in this setting as compared to women in a stereotype threat-only condition (Ben-Zeev et al., 2005). Being permitted to misattribute any negative activating emotions as the effects of a subliminal noise could be connected to another study which showed emotion suppression under stereotype threat.

Johns and colleagues (2008) observed that telling students in a stereotype threat condition that the researchers would be measuring anxiety (as opposed to a neutral explanation) resulted in the students focusing less on anxiety-focused words within the measure and performing worse in working memory and math tests. Decreased working memory was in spite of the fact that participants did not report significant amounts of anxiety on a self-report questionnaire compared to the students in the non-threat or neutral explanation conditions. According to Johns and colleagues (2008), this finding can be explained by the students under stereotype threat trying to suppress their expression of anxiety and this suppression depletes executive resources necessary for success in the task. They also found that reappraising the task as objective over personal or

reappraising their anxiety as useful over harmful would reduce the effects of stereotype threat (Johns et al., 2008). While this set of studies produced an interesting result and contributed to the literature on both stereotype threat and anxiety, they also had some methodological limitations. In particular, three of their four studies included only white women, indicating that their results may only be applicable to white women in mathematics (Johns et al., 2008).

One study attempted to review stereotype threat effects through event-related potentials (ERP) instead of self-report measures. These ERP measured initial sensitivity to feedback valence and tracked the dynamics of arousal up-regulation (which can show either rumination or suppression of emotions; Mangels et al., 2012). Under stereotype threatening conditions, initial detection of negative feedback predicted how deeply the participant interacted with the learning tools available, showing that stereotype threat created an avoidance of learning after or from a perceived poor performance. Like the study from Johns and colleagues (2008), this study also suffers from restrictive population choice. In this case, the researchers determined that they should exclude Asian women from the study, due to possible stereotype boost in mathematics for people with this social identity, even though Asian women still experience stereotype threat under gender-based stereotype threatening conditions (Shih et al., 2002) and even though Asian women are subjected to the model minority stereotype leading to negative performance outcomes (Nabb, 2022). Therefore, the experiences of Asian women were not considered. An alternative solution may have been separate or intersectional analyses.

Taken together, if stereotype threat has a cognitive component, then it includes increased arousal, vigilance, and rumination alongside attempted anxiety and learning suppression. The combination of rumination and vigilance, in particular, might be summarized as “worries”, which is the cognitive component for anxiety (Pekrun, 2006). Suppression of anxiety, however,

is not necessarily a feature of anxiety itself. This combination of results may indicate a correlation between stereotype threat and anxiety, as opposed to stereotype threat acting as a type of anxiety.

The Motivational Component

Stereotype threat tends to induce a motivation construct referred to as *performance-avoidance goals* – trying to appear to not be doing worse than others and to avoid appearing incompetent (Senko et al., 2011). These goals inspire motivational patterns that include higher anxiety, more disorganized study habits, avoiding seeking help, acting in ways that hinder their goal-attainment, lower achievement, and lower interest (Senko et al., 2011), which negatively affects performance. In a surprising outcome of a study that simultaneously induced performance-avoidance goals and stereotype threat, the motivational matchup between the two resulted in positive performance outcomes, linking a motivational mediator for stereotype threat on performance (Chalabaev et al., 2012). Some effects of stereotype threat that may also serve within a motivational component are lower self-esteem (Henschel et al., 2023; Lesko & Corpus, 2006) and intentionally shallow studying techniques (Mangels et al., 2012) in girls or women experiencing stereotype threat. In a longitudinal exploration of the effects of race-based stereotype threatening conditions in postsecondary engineering, students with higher stereotype threat experienced a faster decline in attainment value, steeper increases in effort cost, and completed fewer STEM courses over the course of their degree (Totonchi et al., 2021).

Taken together, drawing from the extant literature, if stereotype threat has a motivational component as an emotion, then it includes low self-esteem, declining attainment value for the domain, steep increases in effort cost for the domain, and is mediated by performance-avoidance goals. The motivational component for anxiety is avoidance motivation, which seems to match

that of stereotype threat (Pekrun, 2006). Matching motivational components does not necessarily indicate that stereotype threat and achievement anxiety are the same construct, since it is possible that (a) experiencing stereotype threat leads to anxiety which has an avoidance motivation or (b) anxiety brought on by environmental factors has an avoidance motivation that occurs alongside induced stereotype threat. It is with these two possibilities in mind that the first research question of this dissertation study is formed – namely to what extent stereotype threat predicts achievement anxiety.

The Expressive Component

An expressive component suggests that someone experiencing stereotype threat might have certain facial expressions or body language associated with their experience. There are no known bodies of work that measure this component of stereotype threat, and any existing measure for this component could not be measured by an observer, since facial expressions and body language are tied more to culture than to biology (Gendron et al., 2014). The expressive component for anxiety is an anxious facial expression (Pekrun, 2006), which, again, cannot be observationally measured. Attempts to measure an expressive component would need to include multiple independent observations, an extremely targeted cultural group of participants which match the cultural group of observers, and member checking with participants. The expressive component, then, is beyond the scope of the current study since I aimed to study the experiences of many groups of students who vary in cultural group and norms.

The Affective Component

The affective component of stereotype threat would likely involve similar affective components to anxiety (Henschel et al., 2023; Johns et al., 2008; Raymond, 2014; Schmader & Johns, 2003) or dejection emotions (Keller & Dauenheimer, 2003). The affective

component for anxiety involves uneasiness and nervous feelings (Pekrun, 2006). Therefore, in this section, I will discuss anxiety research and its relationship to mathematics, connecting the research from stereotype threat.

Anxiety and Stereotype Threat. Anxiety has an affective component (uneasiness and nervous feelings), a cognitive component (worries), a motivational component (avoidance motivation), an expressive component (anxious facial expressions), and a physiological component (peripheral physiological activity; Pekrun, 2006). High anxiety may be a result of certain control and value appraisals (see Chapter 1; Pekrun, 2006) or performance avoidance goals – either trying to not appear to do worse than others or trying to not have a skill decline (Senko et al., 2011). Researchers have seen a particular type of anxiety in studies on mathematics performance: math anxiety.

Math anxiety is a "feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, 2002, p. 181). This definition may sound familiar since it appears to overlap with the definition of stereotype threat. They both involve some form of tension as it relates to performance. In fact, like stereotype threat, there are gender differences in the experience of math anxiety, with girls and women often having higher levels of math/STEM anxiety than boys or men (Ashcraft, 2002; Frenzel et al., 2007; Henschel et al., 2023; Leker, 2017). Additionally, there may be racial differences in the experience of math anxiety throughout adolescence, with Black and Hispanic students having a consistently high level of math anxiety compared to white students (Ahmed, 2018). It is possible that these differences in math anxiety experiences for students of different gender identities and racial identities are due to something like stereotype threat. There are also many similarities in stereotype threat effects and math anxiety effects. For example, like stereotype threat, math anxiety has been shown to lead

students away from the mathematics domain (Ashcraft, 2002; Frenzel et al., 2007; Hembree, 1990; Leker, 2017) and affect the performance in and/or learning of mathematics (Raymond, 2014; Tomasetto et al., 2021). Working memory capacity is also affected by math anxiety, similar to the effects of stereotype threat (Herts & Beilock, 2017). Math anxiety studies have some parallel results to that of stereotype threat studies, but there are also studies which involve both stereotype threat and anxiety.

Anxiety has been studied as a potential correlate or mediator for stereotype threat. In one study, moderate stereotype threatening conditions induced more anxiety for the Latine participants than non-Latine participants (Schmader & Johns, 2003). Interestingly, there were no gender identity-related threat effects. Additionally, the self-reported levels of anxiety were unrelated to working memory capacity scores in this study. Not finding a correlation between anxiety and working memory capacity in this study does not necessarily mean that anxiety and working memory capacity aren't correlated; instead, it may indicate that the measures in the study may not be reliable. This study – like others on the topic of stereotype threat and anxiety (Aronson et al., 1999; Spencer et al., 1999) – used the State-Trait Anxiety Inventory (STAI). However, the STAI was designed and validated for clinical and caregiver settings, not achievement settings (*The State-Trait Anxiety Inventory (STAI)*, 2011). Although the STAI has suitable internal consistency and test-retest reliability, the STAI has trouble distinguishing between types of anxiety or distinguishing anxiety from clinical depression (Caci et al., 2003). As a result, it may not be the most appropriate measure for achievement anxiety in a stereotype threat study.

In another set of studies relating stereotype threat and anxiety, the researchers measured their participants' attention to anxiety-related words on a screen (Johns et al., 2008). Participants

at risk for stereotype threat – women and Latine participants – who were subjected to a moderate stereotype threat manipulation and who thought the task was measuring anxiety directed their attention away from words about anxiety. The researchers also administered a self-report measure of anxiety and found no significant results from those reports. That is, the women and Latine participants in the set of studies were experiencing anxiety but were not reporting it (Johns et al., 2008). Differences in reporting may be why there is some contention between whether anxiety truly correlates with or mediates the effects of stereotype threat on performance (Schmader & Johns, 2003). Stereotype threat itself has also been inconsistent in self-report measures (Leker, 2017; Picho & Brown, 2011). It is tempting to explain the parallel effects of anxiety or math anxiety and stereotype threat as a correlation or mediating effect of one construct on the other (i.e., anxiety onto stereotype threat for math performance; Johns et al., 2008; Osborne, 2001; Schmader & Johns, 2003) or to say that one construct is a subconstruct of the other (i.e., to call stereotype threat a subconstruct of anxiety; Herts & Beilock, 2017; Lira, 2022; Totonchi et al., 2021). With inconsistent results, however, either is a difficult argument to make – creating the problem from this dissertation study, which is that stereotype threat hides behind achievement anxiety, or vice versa. Rather, we do not know when interventions focused on ameliorating stereotype threat or addressing causes of anxiety, or both, are necessary to improve students' mathematics experiences.

In summary, drawing from the extant literature, anxiety appears to be a parallel or overlapping construct to that of stereotype threat in terms of the previously-mentioned components of an emotion. Untangling this relationship requires more than a look at these components, however, and should also consider antecedents and other operational effects of

stereotype threat. To do so in the current research, I turn to my primary theoretical framework – Control-Value Theory.

Stereotype Threat as Viewed Through the Control-Value Theory of Emotions

As I stated in Chapter 1, emotions may occur during an activity, waiting for feedback, or immediately following the receipt of feedback. Drawing from CVT, the type of emotion that occurs depends upon the perceptions of the student in terms of (a) who is in control or how much control the student has and (b) how much of certain types of value for the activity the student may have (Pekrun, 2006). Not many studies have viewed stereotype threat through this theoretical framework, including those defining stereotype threat as a type of anxiety (Herts & Beilock, 2017; Lira, 2022; Totonchi et al., 2021). As a result, to my knowledge, locus of control in stereotype threat has not been studied, but has been recommended as a future direction in a study identifying and validating a self-report measure for stereotype threat (Picho & Brown, 2011).

Unlike the lack of literature relating locus of control and stereotype threat, the idea of value in stereotype threat has been studied to a certain extent. Researchers have not, to my knowledge, viewed stereotype threat through having intrinsic, extrinsic, or outcome values like CVT. However, stereotype threat has been shown to be most prevalent in those who have a high domain identity (Keller & Dauenheimer, 2003; Leker, 2017; Lesko & Corpus, 2006; Murphy et al., 2007; Steele, 1997; Totonchi et al., 2021). That is, a student who identifies themselves with the domain of mathematics feels like they are good at mathematics and finds value in being good at mathematics (Steele, 1997), which is much like having a high attainment value for mathematics (as seen in SEVT; Eccles & Wigfield, 2020). An interesting result in a study assessing emotions of middle school boys and girls alongside some other motivational aspects

found that girls had lower value for the subject of mathematics and felt that their skills in mathematics were low as compared to what boys thought about the subject and their skill set within it (Frenzel et al., 2007). This result shows a distinction between stereotype threat and anxiety, perhaps one that could suggest stereotype threat occurs before anxiety, with anxiety reducing domain identity for those who experience stereotype threat.

Learning strategies employed by those experiencing certain achievement emotions reflects another aspect of control-value theory. However, stereotype threat has been shown to result in shallow or superficial learning strategies (Mangels et al., 2012). Negative activating emotions, like anxiety, also produce superficial learning strategies (Pekrun, 2006). Taken together, then, viewing stereotype threat through the constructs in CVT thus suggests that anxiety and stereotype threat are not subconstructs of each other, as they appear to depend upon different values for the domain – but relationships between the control, value, and antecedents of anxiety and stereotype threat could indicate a correlational or predictive relationship between the two.

Research Gaps

In summary, research on stereotype threat has yielded a positive, correlational relationship to anxiety (Aronson et al., 1999; Johns et al., 2008; Schmader & Johns, 2003; Spencer et al., 1999), evidence for suppression of anxiety (Johns et al., 2008), or did not find an expected relationship (Keller & Dauenheimer, 2003; Schmader & Johns, 2003; Steele & Aronson, 1995). The preceding literature review reinforces why at least a positive correlation between anxiety and stereotype threat would exist, and some reasons for why they are not the same construct – or even type of construct. However, many of these studies face methodological limitations for understanding the relationship between stereotype threat and anxiety for students

in a mathematics classroom, either through restrictive sampling (Johns et al., 2008; Mangels et al., 2012), data collection outside of a classroom setting (Aronson et al., 1999; Ben-Zeev et al., 2005; Blascovich et al., 2001; Johns et al., 2008; Mangels et al., 2012; Murphy et al., 2007; Raymond, 2014; Schmader & Johns, 2003), or inappropriate measures for achievement anxiety (Aronson et al., 1999; Schmader & Johns, 2003; Spencer et al., 1999). These methodological limitations mean that we are not seeing a full picture of the relationship between stereotype threat and achievement anxiety – either because we are only considering a single identity (i.e., white women; Johns et al., 1999); we are focused on experimental conditions that will not necessarily generalize to a classroom setting (i.e., Blascovich et al., 2001); or we are actually measuring clinical anxiety (i.e., Spencer et al., 1999). Careful methodological consideration is necessary to begin the process of untangling the relationship between stereotype threat and achievement anxiety in mathematics.

This dissertation study aims to reduce these methodological limitations by designing it from a QuantCrit perspective. In particular, a study in stereotype threat in mathematics already tends to address the *centrality of racism* (by acknowledging that different scores on tests have been more correlated to stereotypes than to features of humans). Additionally, stereotype threat as a construct looked beyond false, biological explanations that had been published to explain the differences in performance between social identity groups, acknowledging *numbers are not neutral*. This study furthers this work by more deeply recognizing that *numbers are not neutral*, by qualitatively analyzing some quantitative data and giving participants the opportunity to read, reflect, and respond to this analysis. This study additionally furthers this work by recognizing that *groups are neither 'natural' nor 'given'* by using open-response questions for social identity and sampling as many students as possible who can then self-identify themselves in whichever

ways make most meaningful sense to them. This study also recognizes that *data cannot speak for itself* by considering choosing measures for anxiety, stereotype threat, and stereotype threat effects. In particular, I use instruments that are previously validated and intended for use on the relevant construct– the measurements for achievement anxiety and stereotype threat are adapted and condensed, respectively, from two existing instruments (Bieleke et al., 2021; Picho & Brown, 2011) and the measure for stereotype threat effects (i.e., math performance) is a condensed version of the practice Quantitative section of the general GRE. Finally, this study has a *social justice/equity orientation* with an eye toward making tangible change in a classroom setting for those most affected by stereotype threat. In particular, the last research question of this study is created with the expectation that mixed analysis and mixing data will result in research and classroom recommendations that expand upon previous results and/or challenge the norm. Consistent with this goal, the study takes place entirely in a real classroom of students with time borrowed from their regularly scheduled class meeting.

This dissertation study contributes significantly to the literature through these careful methodological considerations, particularly because (a) QuantCrit is relatively new as a methodological framework within educational psychology and (b) this is the first known study that gives such careful methodological consideration to stereotype threat research through a QuantCrit lens. Because of these careful considerations, it also contributes to a better understanding of the relationship between stereotype threat and anxiety through a predominantly CVT lens.

In Chapter 3

In this literature review, I have discussed the extant research for stereotype threat – including stereotype threat effects and stereotype threat manipulations – and components,

antecedents, and results of emotions as they relate to stereotype threat, including studies specifically for undergraduate mathematics courses. In doing so, I aimed to illustrate the reasons that anxiety has been researched as being closely related to stereotype threat and to determine factors which may have led to inconsistent findings in studies relating anxiety to stereotype threat. Stereotype threat can be manipulated through subtle, moderate, or explicit changes to instructions, descriptions, or environments surrounding a task. Stereotype threat manipulations can affect performance or speed; levels of anxiety, dejection, arousal, or vigilance; blood pressure, heart rate, or sweating; working memory capacity; and changes to self-esteem, effort, and performance-avoidance goals. Stereotype threat appears to have a close relationship to emotions, having a physiological component (increased heart rate, blood pressure, and sweating), a cognitive component (decreased memory capacity; increased arousal, vigilance, and rumination); and a motivational component (declining attainment value; increasing effort cost). It is not clear what an expressive component or an affective component may include, though there is strong evidence that the affective component is related to anxiety.

Taken together, then, the extant literature provides strong evidence that stereotype threat is entangled with the idea of emotion, specifically anxiety. In Chapter 3, I outline the methodology for this dissertation study which aims to further untangle the experiences of stereotype threat and anxiety.

Chapter 3: Methods

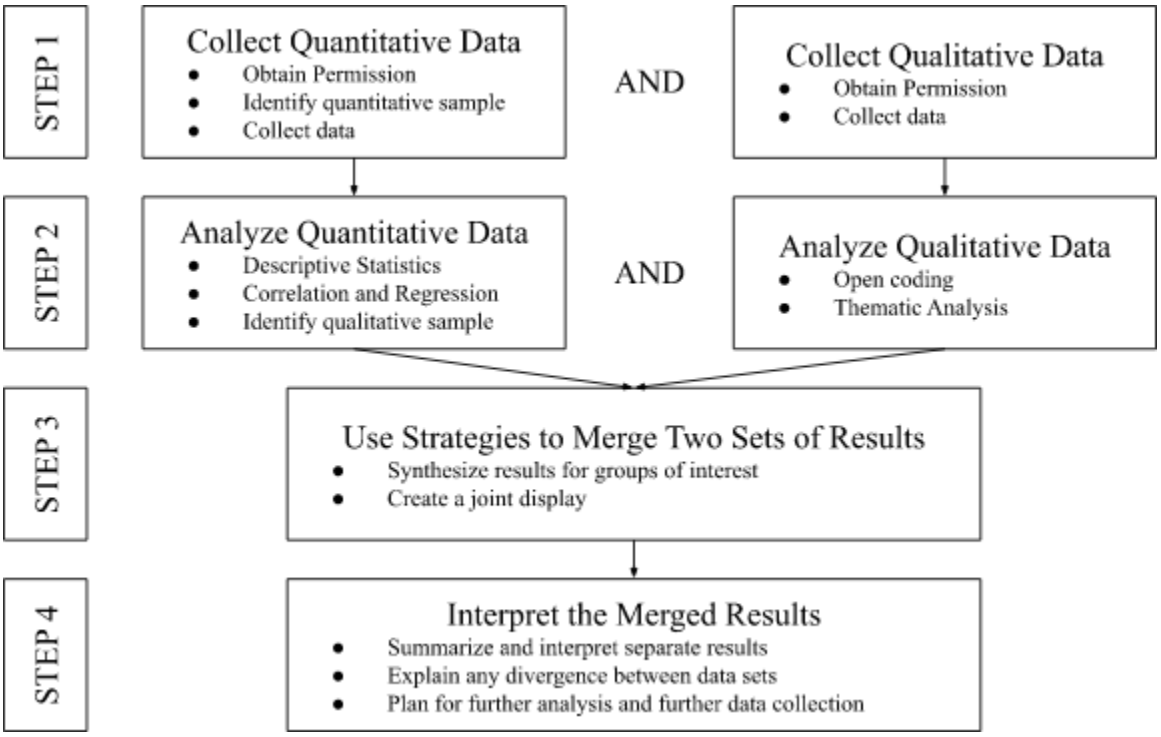
In Chapter 2, I reviewed the literature on stereotype threat in terms of its relationship to emotions – particularly anxiety – and in terms of methodology through the lens of QuantCrit. In this chapter, I outline the methodological approach I adopted to answer the research questions laid out at the end of Chapter 1: a mixed methods study. I am choosing a mixed methods study because the research questions from Chapter 1 would be insufficiently answered through one methodology alone. In particular, the quantitative portion of the study aims to address the extent to which anxiety is predicted by stereotype threat and the extent to which anxiety predicts the effects of stereotype threat. To explain any of the correlational or predictive relationships between anxiety and stereotype threat or its effects, especially for students with social identities and experiences that are often lost in the aggregate of quantitative analyses, the qualitative portion of the study is a necessary addition to the quantitative design. Additionally, integration of this data allows for more complete explanations of stereotype threat and achievement anxiety experiences than one methodology alone. Namely, integrating quantitative and qualitative data shows that "there are real lives at stake that are being determined by those in power" (Mertens, 2007, p. 214), building upon the QuantCrit-mixed methodology work of Ovink and colleagues (2022), who found that quantitative results on certain constructs were too nuanced to be accurate without qualitative data, but that qualitative data was too specific to be generalizable. The complementarity in this dissertation offers a fuller picture of stereotype threat and anxiety – allowing for theoretical, practical, and methodological recommendations in Chapter 5.

As discussed in Chapter 2, theoretical evidence points to at least a correlation between stereotype threat and anxiety, but some research studies have not found this to be the case. This study intends to take careful methodological considerations to assess for a predictive

relationship. In the sections that follow, I will review the purpose statement for the study alongside appropriate hypotheses for the quantitative research questions. I will also discuss the methodological approach and overarching design of the study, where I will outline participant selection and data collection methods in addition to previewing the analyses and presentation of data from Chapters 4 and 5. As a visual guide to the research design and sections of this chapter, see Figure 2 for a flowchart representing the steps in the proposed study.

Figure 2

Flowchart for Mixed Methods Study Steps



The Research Design

In this study, I used a convergent, participatory social-justice mixed methods design (QUAN – QUAL). A *convergent design* occurs with both quantitative and qualitative portions at the same time, often collecting data at the same time; Creswell & Plano Clark, 2018). This design is appropriate because collecting qualitative data about stereotype threat and anxiety

experiences while still potentially experiencing the effects of stereotype threat is important to the integration of the quantitative and qualitative data. Participatory social-justice designs are those that aim "to understand and transform the situation based upon the needs of the participants involved in the research" (DeCuir-Gunby & Schutz, 2017, p. 7). These designs may coincide with convergent designs for the purpose of integrating quantitative data with personal experiences of participants – in this case, students of first-year college mathematics courses – to challenge societal norms (Creswell & Plano Clark, 2018). Because this study aims to challenge research and classroom norms, this design is appropriate. In particular, this dissertation study aims to answer questions about quantitative relationships, qualitative experiences, and integration of the two in order to meet the needs of future students like those in the study.

A primary goal of this study was to further investigate the relationship between anxiety and stereotype threat. Inspired by the aforementioned evidence that stereotype threat sometimes behaves as an emotion construct, which may have an affective component similar to anxiety (Henschel et al., 2023; Johns et al., 2008; Raymond, 2014; Schmader & Johns, 2003), the current research further investigated this possibility. Therefore, the quantitative portion of this study examined associations between the self-report measures of anxiety to (1) stereotype threat and (2) stereotype threat effects (i.e., lower math assessment scores). Additionally, students had the opportunity to share their personal experiences with stereotype threat and anxiety in mathematics. This data was collected to answer the following research questions, which were also described in Chapters 1 and 2:

> (1) To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety?
> (2) To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)?
> (3) How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety

and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task?
(4) How do the quantitative relationships between anxiety and stereotype threat and the qualitative results on perceived relationships between anxiety and stereotype threat for less-represented groups combine to corroborate, extend, or challenge previous research and the typical classroom culture?

Because I some reporting measures for achievement anxiety have likely been measuring the distinct construct of clinical anxiety (Caci et al., 2003), I suspected that this measurement decision has been the cause of contention about the relationship between anxiety and stereotype threat in previous studies. I hypothesized that using an appropriate measure for achievement anxiety in the current study meant that achievement anxiety would be positively predicted by levels of stereotype threat (Hypothesis 1) for the four studied types of stereotype threat: gender-, race-, sexuality-, and income-based. Additionally, I hypothesized that levels of stereotype threat effects would be positively predicted by levels of achievement anxiety (Hypothesis 2).

Participants and Sampling

Like other QuantCrit researchers, in this section, I will outline the overall setting for students in the study (Campbell-Montalvo, 2020). Given the QuantCrit approach to this dissertation, it is important to discuss this overall setting for students because of two tenets: 1) Since *data cannot speak for itself*, it is the responsibility of researchers to think about when and why generalizations of results are reasonable. 2) Furthermore, the *social justice orientation* means that I will be making recommendations for research and classroom work. In both of these tenets, it becomes necessary, then, to be aware of the cultural, political, and geographical environment of this dissertation so that future researchers and educators can make appropriate inferences for their own research and classrooms. This study was conducted at The University of Oklahoma, which was founded in 1890 (Levy, n.d.). The first woman to earn an undergraduate

degree was Fantine Frances Samuels in 1901 (*OU Historical Timeline*, n.d.) and the first woman to earn a doctorate degree was Mary Jane Brown in 1929 (Attalla, n.d.). After two Federal Supreme Court cases, Ada Lois Sipuel Fisher and George McLaurin became two of the first Black students admitted to the university (Brophy, n.d.; Hall, n.d.). Since 2013, there have been instances of public and leaked videos of blackface committed by undergraduate students (Adger, 2019; Li, 2019), a fraternity shut down due to chanting a racial slur (McNutt, 2018), more than one professor using the same racial slur during class (Aston, 2023; Keith, 2020; Miller, 2020a), and protests as Black students continue to fight for their basic campus rights to an equitable education (Dulaney, 2020). Women have seen their abusers go without penalty (Lele, 2023; West, 2016), and sexual assault accusations have been made about professors and administrators alike (Hazelrigg, 2018; Sulley, 2023; Valbrun, 2019). Some of these events have not only caught the eye of national news sites but were additionally featured on Saturday Night Live (Bonnet, 2019; Miller, 2020b). Even if students do not know the origins of the university or struggles of certain groups being admitted or graduating, the last decade has proven eventful and potentially concerning for students in certain groups. This is the environment for students who participated in this dissertation study.

The students in this study were recruited while attending their first-year mathematics course at The University of Oklahoma. A sample of $N = 123$ students were selected from first-year mathematics courses, recruited during their class time (see social identity breakdown in Table 2). This sample size is suitable for a study of this design because the study with the closest construct-correct assessment for anxiety found a correlation to stereotype threat at $r = -0.31$ ($p < .001$; Osborne, 2001), and this level of correlation along with an exploratory (sufficient) level of confidence at 80% requires 51 - 212 participants (Schönbrodt & Perugini, 2013) for

sufficient statistical power. The first-year mathematics course sections recruited for the study were courses at the pre-calculus level on the STEM-track – courses which can be used in progression toward a science, technology, engineering, or mathematics degree. Specifically, students were in courses titled College Algebra and Precalculus/Trigonometry. The instructors of these courses pre-approved my arrival during a 30-minute portion of their class period. The students completed the survey and test instruments in a paper-and-pencil format. I collected data from all consenting students within entire classrooms at a time, instead of focusing on a specific identity, because it would be inappropriate to assume which population, from literature alone, has the most or least stereotype threat in this setting (Castillo & Gilborn, 2022; López et al., 2018). Doing so also would have risked singling out students with minoritized social identities.

Table 2

Social Identity Breakdown of Sample

Gender Identity	**Women**	**Men**	**Trans Man**	**Gender Fluid**			
N (%)	68 (58.62%)	44 (37.93%)	2 (1.72%)	1 (0.86%)			
Racial Identity	**white**	**Black**	**Latine**	**Native American**	**Asian**	**Middle Eastern**	**Multi-racial**
N (%)	69 (59.48%)	20 (17.24%)	16 (13.79%)	12 (10.34%)	9 (7.76%)	1 (0.86%)	20 (17.24%)
Sexuality	**straight**	**Bisexual**	**Gay**	**Queer**			
N (%)	94 (81.03%)	9 (7.76%)	2 (1.72%)	1 (0.86%)			
Number of School Aids	0	1	2	3			
N (%)	13 (11.21%)	46 (39.66%)	25 (21.55%)	5 (4.31%)			

Note. Numbers do not add up to the total number of students in the study due to (1) students choosing not to disclose certain aspects of their identity or (2) students identifying as more than one identity. Students who identified as Asian often also disclosed their family's country of origin, including students identifying as Filipino, Indian, and Vietnamese.

The descriptive information in Table 2 is discussed in more detail in Chapter 4. The categories are created from the open-response and multi-choice items given to the students on their identity survey (see Appendix E). Gender identity included men, women, and gender expansive individuals (including those who identified as trans and gender fluid). Racial identity was difficult to categorize because of the number of students who are multi-racial. In Table 2, these categories are split so that any identity that a student wrote down on the answer line is where they were placed, even if they are counted in more than one category. For example, a student who identified themselves as "Black, white, and Vietnamese" was categorized as Black, white, and Asian in this table. Analyses regarding racial identities are considered in a number of ways, but quantitative analyses based on this table were not possible. Description of the population in this way remains essential to emphasize the importance of considering qualitative data, since over 17% of the sample is multi-racial. Sexuality included those who were straight, bisexual, gay, or queer. Income levels included those who checked 0, 1, 2, or 3 of the available financial aid options (using Federal Pell grants, Federal loans, or private loans). A couple of students wrote in "GI Bill". None of those who did so also marked the Federal Pell Grant box, so these two financial aid options were aggregated for those students. I make note here that having other identities as open response may have encouraged these students to write in detail about their financial aid that I had not thought to consider, and which creates a more accurate leveling for financial help with their schooling.

Instruments

One reason to include both qualitative and quantitative data collection within the same set of instruments administered during class time is that this population has shown hesitancy to volunteer for a previous qualitative study outside of class time. In contrast, a previous quantitative study conducted in the classroom had nearly all students participate – possibly because they do not have to give up any outside-of-class time to participate. While I sacrificed the flexibility and deep questioning of semi-structured interviews for this study, I gained the ability to collect many multiple perspectives on a few targeted questions in a structured format (Esterberg, 2002).

Stereotype Threat Environment

This study did not include an explicit or moderate stereotype threat manipulation. As shown in previous studies, stereotype threat occurs with very little assistance from researchers. It can occur from explicit manipulations (Armenta, 2010; Chalabaev et al., 2012; Johns et al., 2008; Keller & Dauenheimer, 2003; Lesko & Corpus, 2006; Mangels et al., 2012; Spencer et al., 1999; Tine & Gotlieb, 2013) or very subtle manipulations (Ben-Zeev et al., 2005; McGlone & Aronson, 2007; Murphy et al., 2007; Raymond, 2014; C. M. Steele & Aronson, 1995). In fact, some studies have shown that no manipulation at all still produces stereotype threat effects (Ben-Zeev et al., 2005; Spencer et al., 1999) in comparison to stereotype threat reduction techniques. Additionally, stereotype threat manipulations have the ability to negatively affect long-term learning (Mangels et al., 2012). Because of these previous findings, I did not find it necessary to manipulate particular students into stereotype threat and attempted to capture their experience on an assessment as naturally as possible. The math performance assessment (described in the following section) may have served as a manipulation to induce anxiety or stereotype threat by existence alone, but there were no attempts to make the assessment more stressful than a typical

timed assessment from class. All participants received the same set of instructions on the math performance assessment.

Math Performance

Previous studies on stereotype threat have used questions from or similar to the quantitative sections of the General Record Examination (GRE; Johns et al., 2008; Lesko & Corpus, 2006; Mangels et al., 2012; McGlone & Aronson, 2007; Schmader & Johns, 2003; Tine & Gotlieb, 2013). Because the population had a similar knowledge base, but different course topics, this study also included an assessment similar to the quantitative sections of the GRE – a portion of a Quantitative GRE Practice Test. Although a single quantitative section of the GRE is typically given as 25 questions (both multiple choice and numerical entry) in 40 minutes, this study included a version that is 10 questions in 10 minutes. One reason for this is that the material covered in the assessment was intended to be accessible but challenging. Questions for this math assessment were selected from two sections of a Quantitative GRE Practice Test (50 possible questions) by first excluding items which weren't prerequisite topics for the courses in which the students were enrolled. Questions about statistics and probability were not included since none of the students in this study are required to have knowledge about these topics. Geometry questions were also not included because of the potentially large temporal distance between a previous geometry course and their current mathematics course.

After excluding statistics, probability, and geometry questions, I also excluded questions which would not meet the practical needs of the assessment. Since the students were given 10 minutes, large tables and graphs to interpret or an otherwise time-consuming problem were not appropriate for this assessment. Scoring would also have been less straightforward with numerical entry problems. After excluding problems for these reasons, there were 22 problems

left to choose from. The final version of the assessment included 6 problems which involved basic algebra, and 4 problems which involved relationships between values (such as the use of ratios or covariational reasoning).

Another reason for using a portion of the GRE Practice Test is that the two courses in this study have a different 'habitat' and formatting for their typical assessments. This assessment aimed to be like a challenging quiz. The time constraint to 10 minutes is to mimic the pressure they may feel on a graded and timed assessment, as are typical for their courses. The math performance score for each student was taken as a raw score out of 10 for the number of correct questions. See Appendix A for the math assessment questions.

Self-Reported Stereotype Threat

Stereotype threat has largely been measured through its effects (e.g., performance on an assessment), but researchers have also used the Social Identities and Attitudes Scale (SIAS; Leker, 2017; Picho & Brown, 2011; L. Smith & Cokley, 2016) or the Stereotype Vulnerability Scale (SVS; Spencer, 1993; C. M. Steele & Aronson, 1995; J. Steele et al., 2002). Because the need for a stereotype threat measure is to assess the level of stereotype threat immediately following an assessment, the SVS is more appropriate to use, as opposed to long-term attitudes about identity, like the SIAS tends to measure. The original SVS includes eight items on 7-point Likert-type scales from 1 (strongly disagree) to 7 (strongly agree) with instructions alluding to feelings about gender. Two items are assessment-specific, while the other six items are about general experiences in mathematics. The original SVS had a questionable level of internal consistency with a Cronbach's alpha of 0.67 (Spencer, 1993) – given the general range of $.70$ to $.90$ (Gliem & Gliem, 2003) – with a later study finding a good Cronbach's alpha at $.84$ (J. Steele et al., 2002). The SVS was adapted for the current study to include separate items

referring to gender, race, sexuality, and income subscales, totaling 32 items administered to the students on the day of data collection. See Appendix B for the adapted SVS with all 32 items.

Gender-based Stereotype Threat Subscale. Because the data did not meet the assumption of Tau-equivalence (Hayes and Coutts, 2020), McDonald's omega was used to determine the reliability and internal consistency of the eight-item Gender-based Stereotype Threat Subscale. The initial results indicated poor reliability ($\omega = .58$; Gliem & Gliem, 2003). A closer look at the items revealed that Item 2 ("The test may have been easier for people of my gender.") may have been interpreted by students in such a way that men, women, and gender expansive individuals mostly strongly disagreed with its statement. Although it was intended to be a reverse-coded item, those experiencing stereotype threat and those not experiencing stereotype threat would have similar answers, so it was discarded (The remaining seven items with $\omega = .64$). Item 5 ("People of my gender rarely face unfair evaluations in math classes."), Item 1 ("The experimenters expected me to do poorly on the test because of my gender."), and Item 3 ("I doubt that others would think that I have less math ability because of my gender.") were also discarded – one at a time – due to having negative or extremely small inter-item correlations and covariances with other items. Following these modifications, the Gender-based Stereotype Threat subscale used in Chapters 4 and 5 has acceptable reliability and internal consistency ($\omega = .73$; see Table 3).

Table 3

Gender-based Stereotype Threat Subscale Inter-Item Correlations

Items in Subscale	Item 4	Item 6	Item 7	Item 8
Item 4: Some people feel I have less math ability because of my gender.	1.00			

Item 6: In math classes, people of my gender often face biased evaluations from others.	.61	1.00		
Item 7: My gender does not affect people's perception of my math ability.	.33	.27	1.00	
Item 8: In math classes I often feel that others look down on me because of my gender.	.52	.48	.33	1.00

Race-based Stereotype Threat Subscale. McDonald's omega was also used to determine the reliability and internal consistency of the eight-item Race-based Stereotype Threat Subscale. The initial results indicated questionable reliability ($\omega = .61$). Similar to the Gender subscale, Item 2 ("The test may have been easier for people of my race.") continued to cause confusing results, as students experiencing race-based stereotype boost may have answered Strongly Agree while those experiencing stereotype threat or no stereotyped experiences continued to answer low. This item was, again, discarded ($\omega = .67$). Item 5 ("People of my race rarely face unfair evaluations in math classes.") had negative or extremely low inter-item correlations with five out of the six other items, so was also discarded. The results indicate that the Race-based Stereotype Threat subscale used in Chapters 4 and 5 has acceptable reliability and internal consistency ($\omega = .71$; see Table 4).

Table 4

Race-based Stereotype Threat Subscale Inter-Item Correlations

Items in Subscale	Item 1	Item 3	Item 4	Item 6	Item 7	Item 8
Item 1: The experimenters expected me to do poorly on the test because of my race.	1.00					
Item 3: I doubt that others would think that I have less math ability because of my race.	.27	1.00				

Item 4: Some people feel I have less math ability because of my race.	.58	.27	1.00			
Item 6: In math classes, people of my race often face biased evaluations from others.	.45	.25	.54	1.00		
Item 7: My race does not affect people's perception of my math ability.	.18	.34	.30	.31	1.00	
Item 8: In math classes I often feel that others look down on me because of my race.	.58	.25	.52	.46	.23	1.00

Sexuality-based Stereotype Threat Subscale. McDonald's omega was also used to determine the reliability and internal consistency of the eight-item Sexuality-based Stereotype Threat Subscale. The initial results indicated poor reliability ($\omega = .52$). Like with race- and gender-based stereotype threat, Item 2 ("The test may have been easier for people of my sexuality.") again showed inconsistency with each other item and was discarded ($\omega = .59$). Like gender-based stereotype threat, Item 5 ("People of my sexuality rarely face unfair evaluations in math classes.") had extremely low inter-item correlations with five out of the six other items, so was also thrown out. The results indicate that the Sexuality-based Stereotype Threat subscale used in Chapters 4 and 5 has questionable reliability and internal consistency ($\omega = .68$; see Table 5).

Table 5

Sexuality-based Stereotype Threat Subscale Inter-Item Correlations

Items in Subscale	Item 1	Item 3	Item 4	Item 6	Item 7	Item 8
Item 1: The experimenters expected me to do poorly on the test because of my sexuality.	1.00					

Item 3: I doubt that others would think that I have less math ability because of my sexuality.	.25	1.00				
Item 4: Some people feel I have less math ability because of my sexuality.	.79	.27	1.00			
Item 6: In math classes, people of my sexuality often face biased evaluations from others.	.63	.17	.78	1.00		
Item 7: My sexuality does not affect people's perception of my math ability.	.33	.44	.29	.17	1.00	
Item 8: In math classes I often feel that others look down on me because of my sexuality.	.63	.33	.60	.49	.43	1.00

Income-based Stereotype Threat Subscale. McDonald's omega was again used to determine the reliability and internal consistency of the eight-item Income-based Stereotype Threat Subscale. The initial results indicated acceptable reliability ($\omega = .70$). While the reliability in terms of McDonald's omega look acceptable, Item 2 ("The test may have been easier for people of similar finances.") was involved in negative or extremely small inter-item correlations with six of the seven other items, and I determined that it would be best to discard it ($\omega = .76$). Item 5 ("People of my financial status rarely face unfair evaluations in math classes.") had extremely low inter-item correlations with five out of the six other items, so was – again – discarded. The results indicate that the Income-based Stereotype Threat subscale used in Chapters 4 and 5 has good reliability and internal consistency ($\omega = .82$; see Table 6).

Table 6

Income-based Stereotype Threat Subscale Inter-Item Correlations

Items in Subscale	Item 1	Item 3	Item 4	Item 6	Item 7	Item 8

Item 1: The experimenters expected me to do poorly on the test because of my finances.	1.00					
Item 3: I doubt that others would think that I have less math ability because of my finances.	.27	1.00				
Item 4: Some people feel I have less math ability because of my finances.	.69	.39	1.00			
Item 6: In math classes, people of similar finances often face biased evaluations from others.	.63	.27	.77	1.00		
Item 7: My finances do not affect people's perception of my math ability.	.33	.51	.43	.43	1.00	
Item 8: In math classes I often feel that others look down on me because of my finances.	.62	.35	.78	.71	.44	1.00

Composite scores were created from averaging the individual item scores (after reverse coding the necessary items) in each subscale. In data collection, some students circled areas below 1 and above 7, often as distinct responses from circling 1 or 7. Due to this, composite scores range from 1 to 9.

Self-Reported Anxiety

Previous self-report anxiety measures in stereotype threat studies largely have included researcher-created questionnaires that lack the validity and reliability procedures needed to appropriately use them (Henschel et al., 2023; Leker, 2017; Osborne, 2001; Raymond, 2014) or at least one of the two scales from the State-Trait Anxiety Inventory (STAI; Aronson et al., 1999; Schmader & Johns, 2003; Spencer et al., 1999; Steele & Aronson, 1995). Other anxiety measures have come from the Achievement Emotions Questionnaire - Mathematics (Frenzel et al., 2007), the Manifest Anxiety Scale (Herts & Beilock, 2017), and the Revised Worry-Emotionality Scale

(Keller & Dauenheimer, 2003). Even though the STAI has been used many times in similar studies, it was designed and validated for clinical and caregiver settings, rather than achievement settings (*The State-Trait Anxiety Inventory (STAI)*, 2011). Therefore, a more appropriate measure for anxiety is an adapted subscale of the AEQ from a pilot study of the same population – which I will call the Achievement Anxiety Questionnaire (AAQ) because it aims to measure only achievement anxiety and not clinical anxiety (see Appendix C for the retained anxiety subscale). The full AEQ, as described below, is aimed at assessing achievement emotions upon reflections of previous experiences in general education settings and is not subject specific. This dissertation, however, needed an instrument to measure only anxiety, in the subject of mathematics, and only on the just-taken mathematics assessment. I used a pilot study to adapt the full AEQ into a shortened version geared towards mathematics problem solving.

Pilot Study. I conducted a pilot study on a sample of 148 first-year mathematics students at The University of Oklahoma (i.e., the same population as this dissertation) to validate a survey instrument, which would satisfy the need for a shortened Achievement Emotions Questionnaire for Mathematics Problem Solving (AEQ - MPS). The purpose of re-analyzing this instrument among the current sample is for use in this dissertation study.

The AEQ. The Achievement Emotions Questionnaire originally measured nine emotions (enjoyment, hope, pride, anger, anxiety, shame, hopelessness, boredom, and relief) in three settings (class, studying, and testing) covering all four questionnaire-measurable components of each emotion (affective, cognitive, motivational, and physiological; Pekrun et al., 2011). A shortened version containing 96 of the original items (and previously validated for other populations; Bieleke et al., 2021) was administered in this pilot study alongside measures of

construct validity, which will not be discussed here, as they were used for validity measures of the full scale. The AEQ items asked students to respond on 5-point Likert-type scales.

A New Anxiety Scale. Using only the three anxiety subscales of the AEQ-S, I ran an exploratory factor analysis. After one item was deleted due to low correlations and a low anti-image value, the remaining 11 items loaded onto 2 or 3 factors. The first factor, accounting for 40% of the variance in anxiety, loaded all test-related items and two of the learning-related items. This factor served as an achievement anxiety scale – the AAQ. McDonald's omega for this scale in the pilot study was .84, which is good for analysis of reliability (Gliem & Gliem, 2003).

Within the confines of the previously collected data, I used the new scale ($M = 3.38, SD = 0.67$) to assess whether achievement anxiety might be high for students with and without the potential for experiencing stereotype threat based on the population and previous research. These independent sample *t*-test comparisons suggested that the $N = 117$ students with at least one piece of their identity having negative stereotypes in mathematics ($M = 3.44, SD = 0.64$) had significantly higher anxiety than those with no (reported) piece of their identity having negative stereotypes in mathematics ($M = 3.11, SD = .74, t(145) = -.21, p = .018$). Identities with negative stereotypes were chosen based on the literature for who would be most at risk of experiencing stereotype threat – including women or gender-expansive individuals, students who had a non-white or non-Asian identity, students with a learning disability, students who were first-generation, and students who were not heterosexual. These results suggest that (1) this 6-item subscale may be used (after context-specific modification) to assess achievement anxiety and (2) that a similar population of students could have at least 70% of the students at risk for stereotype threat and its effects. One lesson that was learned from the pilot study was that for

some (but not all) participants, the survey was taken immediately following an in-class assessment, which may have resulted in elevated anxiety levels for these students. I did not collect data about which students had an in-class assessment before this survey, after this survey, or not at all in the pilot study so do not have results about whether this had an effect. In the current study, I only collected data on a non-assessment day to avoid the possibility of a different assessment affecting anxiety levels during this study.

The AAQ, as described in the pilot study above, included the emotion of achievement anxiety during the testing situation which had just occurred. This subscale has six items on 5-point Likert-type scales ranging from 1 (strongly disagree) to 5 (strongly agree). Cronbach's alpha coefficient was used to determine the reliability and internal consistency of the six-item Achievement Anxiety Questionnaire from this dissertation study. The results indicate that scale Anxiety has good reliability and internal consistency ($\omega = .88$; see Table 7). This measure was scored by averaging the six item scores to obtain a composite score. See Appendix C for the modified AAQ. Similar to the SVS, some students responded beyond the scale, so composite scores range from 1 to 7.

Table 7

Anxiety Scale Inter-Item Correlations

Items in Scale	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
Item 1: I was worried I wouldn't be able to cope with the assessment	1.00					
Item 2: Worrying about not completing the assessment made me sweat.	.32	1.00				
Item 3: I got so nervous I wish I could have just skipped the assessment	.45	.55	1.00			

Item 4: I was worried that the test would be too difficult	.56	.42	.58	1.00		
Item 5: At the beginning of the test, my heart started pounding.	.30	.71	070	.44	1.00	
Item 6: I was very nervous.	.44	.78	.68	.53	.83	1.00

In the next two sections, I will outline the survey intended to capture anxiety and stereotype threat experiences of students using open-response questions and an identity survey.

Experience Survey

Because the experience survey (see Appendix D) was part of a single data collection alongside a math test and quantitative scales on anxiety and stereotype threat, I chose to limit the experience survey to two open-ended items. The first question served to probe whether they experienced anxiety or an experience similar to it. The second question served to connect their emotions (positive or negative) to society's deficits in education. The credibility of this instrument was assured after expert panel review (three educational psychology researchers and one researcher in undergraduate mathematics education – my dissertation committee) of the items and instrument instructions. These two open-ended experience questions are intended to extend upon the stereotype threat and anxiety scales the students filled out immediately before. They are targeted enough to suggest they discuss their emotions and their identity experiences, but general enough to allow them room to connect other emotions or other ideas besides something like stereotype threat to their experience on the assessment in the study. It is important to give directions without being too specific in these open-ended questions to allow as full a picture of their experience on the assessment as possible.

Identity Survey

The identity survey was provided last so that all questions in the previous sections were answered without salience being induced outside of the content of those questions, as salience of a particular identity can induce stereotype threat (McGlone & Aronson, 2006). This survey requested their racial identity, gender identity, age, and sexual identity as open-response questions, as self-identification is an important aspect of appropriately considering the experiences of participants when analyzing the qualitative data (Curley, 2019; Jang, 2018). These open-response questions were aggregated for quantitative analysis, as needed, but every attempt was made not to overly combine categories to the point of meaninglessness (Doucet, 2019; Gillborn et al., 2018). There was also a multi-check box question where students answered if they had received (a) a federal Pell grant, (b) a student loan, and/or (c) a private loan to pay for school. A score of 0 through 3 were assigned based on the number of choices they selected. This measure served as a proxy for describing income-based or socioeconomic status-based experiences. In the aforementioned pilot study, income-based information was muddied by most students not knowing or not reporting their household income. Given the setting of this study and age of most participants, it was my hope that more students would be familiar with their financial aid packages than their parents' specific income. Additionally, there were two questions about their mathematics identity, rated on a 7-point Likert-type scale from 1 (strongly disagree) to 7 (strongly agree). Next, there was a question about their most recently returned mathematics assessment (quiz or exam), where they could provide the number of points they received out of a certain total. Finally, there was a question which allowed students to provide their email address should they be willing to be contacted for clarification on their open-response questions later. See Appendix E for the identity survey.

Additional Items

Due to previous experience with collecting data in this population, I found it to be useful to include attentiveness checking questions within the survey. To do so, I added some version of "Please circle ___ below" in three different locations of the overall instrument packet. I decided to discard student's data from the analysis if (a) their packet had more than one of these questions with the incorrect item selected or (b) if they have one incorrect item selected and there is no meaningful response to the open-response questions (i.e., if those questions are blank). Additionally, data was not considered in the quantitative analysis if they chose not to disclose their identity in any way, or otherwise concealed their identity behind false answers to the identity questions. Based on these criteria, there were seven students who needed to be removed from quantitative data analysis entirely (resulting in a total $N = 116$). However, the total for an individual statistical test may vary depending on how many students chose not to disclose the relevant identity.

The Research Procedures

After receiving IRB approval (#15817) I attended a 30-minute segment of classes on a day when instructors had enough time for data collections. I read to the students a short description for the study, provided in Appendix F, while handing each student a manila envelope containing a loose sheet with a consent handout (see Appendix G) and a stapled packet. I asked them to wait for instructions on each portion of the stapled packet. They read the consent handout, then took the math assessment, which would last 10 minutes. A STOP symbol was at the end of the math assessment, to remind them to wait for further instruction. When 10 minutes passed, I asked them to take the remaining time for the surveys which followed – including the stereotype threat subscales, anxiety scale, the open-response questions about their experiences on

the math assessment, and the identity survey. Packets were printed so that half had the stereotype threat subscale before the anxiety scale with the other half printed with the anxiety scale first. When they had completed all surveys, they placed their packet back into the envelope, were given a debrief document (see Appendix H) and decided whether to give me their packet for data analysis or keep it (thus opting out of the study). Six students decided to opt out in this way. Except for reading instructions to the class, I remained in the hallway to avoid being able to identify which students decided not to participate.

Plans for Data Analysis

In this section, I outline the statistical analysis plans laid out by research question.

Quantitative Data Analysis

Research Question 1: To what extent does gender-, race-, sexuality-, and income-based stereotype threat predict achievement anxiety? Especially because of the relatively small sample size ($N = 116$), it was important to determine the normality of the sample for each of the five variables involved in this research question – gender-based stereotype threat, race-based stereotype threat, sexuality-based stereotype threat, income-based stereotype threat, and achievement anxiety (Blanca et al., 2017). A Shapiro-Wilk test (Pituch & Stevens, 2015) was performed for each variable, and showed that the distribution varied significantly from normality for each (see Table 8). Therefore, I conducted a non-parametric correlation analysis between the achievement anxiety score and each stereotype threat score. Correlation analysis is the appropriate assessment because achievement anxiety item scores were averaged to create a composite score that approaches continuity (de Winter & Dodou, 2012). This analysis was conducted using the Spearman's Rank Order Correlations in IBM SPSS. If a correlation was seen between anxiety and any subscale score of stereotype threat, then I performed a simple

linear regression to model the relationship between achievement anxiety as the criterion and the relevant stereotype threat as the predictor. The quantitative analysis was conducted in IBM SPSS. This analysis procedure was followed for each of the four subscales of stereotype threat and the total stereotype threat score.

Table 8

Shapiro-Wilk Test Results for Stereotype Threat and Anxiety

Variable	N	W	p
Gender-based Stereotype Threat	116	.93	$< .001$
Race-based Stereotype Threat	116	.94	$< .001$
Sexuality-based Stereotype Threat	116	.84	$< .001$
Income-based Stereotype Threat	116	.87	$< .001$
Achievement Anxiety	116	.96	$< .001$

Research Question 2: To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)? A Shapiro-Wilk test was performed for math assessment scores and showed that the distribution varied significantly from normality ($W = .91,\ p < .001$). Therefore, I conducted a non-parametric correlation between the achievement anxiety score and the math assessment score. Again, these averaged composites may be treated as continuous. This analysis was conducted using the Spearman's Rank Order Correlations in IBM SPSS. If correlation was significant, I again performed a simple linear regression with performance entered as a criterion and anxiety as a predictor. Due to collecting their anxiety data after they take the assessment, care must be taken when interpreting these results. Additionally, I ran a linear regression with their anxiety listed as criterion and an actual recent assessment score from their class as the predictor. This was also conducted in IBM SPSS.

In both of these quantitative research questions, I do not reject results slightly higher than $p = .05$, but less than $p = .10$ as being "not significant". This decision is because of my methodological lens of QuantCrit, and the tenet stating that data cannot speak for itself (Gillborn et al., 2018). Rather, the p-values may not fall within ranges of traditionally accepted statistical significance, but this does not stop the results from being practically significant (Pitak-Arnnop et al., 2010).

Additional Quantitative Analyses to Assist in Answering Research Question 3. How do students envision their anxiety and stereotype threat effects as they relate to their self-report measures of anxiety and stereotype threat? In Research Question 3, I intended to analyze the qualitative data for only a portion of the full sample. To determine which students to analyze, I first only considered those who had code-able responses to the open-response experience questions (i.e., not including responses that were blank or saying only "yes" or "no" as the response). I then selected students from that subset for analysis based on certain criteria. In particular, I sought a deeper understanding of student experiences among identity groups that may typically be lost in the aggregate of the quantitative analysis due to size of the group. The students included in this way were those who identified as Middle Eastern ($n = 1$), trans man ($n = 2$), gender fluid ($n = 1$), straight/bicurious ($n = 1$), and Filipino ($n = 1$). In the same vein, I also included students who were multi-racial ($n = 8$). In addition, I selected students for qualitative analysis by choosing those who differed from the population of reference. Because one-way Analysis of Variance (ANOVA) can tolerate non-normality (Blanca et al., 2017), I conducted two separate one-way ANOVAs to assess if there were groups which differed from one another on anxiety and stereotype threat, respectively. I then used Games-Howell as a post hoc test to assess which groups were significantly different from the group(s) with the lowest

mean for anxiety and stereotype threat. Games-Howell is a suitable choice because it does not require equal size groups or variances, and it has acceptable power while controlling Type I error (Sauder & DeMars, 2019). Based on the data from this dissertation, the groups with the lowest levels of self-reported stereotype threat and/or anxiety are white, Native American, men, straight, or bisexual/queer students (see Table 9). Groups with statistically higher stereotype threat and anxiety are those that I chose to analyze further – students who identify as Black, women, or gay Finally, there were two students who did not provide any identity markers, and therefore were not included in the quantitative data analysis but were included in the qualitative data analysis for their open-response answers regarding their experiences.

In running a one-way ANOVA for racial identity in stereotype threat and anxiety, I identified racial identity in two ways. First, racial identity was identified by selecting the single racial identity that the student wrote down first, under the assumption that the identity that we write down first is most salient (Liebler & Halpern-Manners, 2008). As a sensitivity analysis to the first one-way ANOVA with hopes of addressing the complexities of racial identity for students who identify as more than one race (17% of the full sample), I also created 6 individual variables for racial identification (Allen & Turner, 2001) – white, Black, Native American, Asian, Latine, and Middle Eastern – which would be valued at 0 if they did not identify that way, 1 if they only identified that way, and otherwise would evenly split the value of 1.0 across all identified identities. For example, a student who identified as white and Black would have 0.5 under the variable for white, 0.5 under the variable for Black, and 0 for the other four variables. These variables were used in a multiple linear regression to corroborate the one-way ANOVA.

Table 9

Descriptive Statistics for Population of Reference Identities

Population of Reference Identity	N	Anxiety M	Anxiety SD	Relevant Stereotype Threat (ST) Scale	ST M	ST SD
white	63	3.03	1.31	Race	2.57*	1.33
Native American	9	3.22	1.78	Race	2.41**	1.00
Men	44	2.76	1.35	Gender	2.49*	1.03
Straight	94	2.94**	1.34	Sexuality	2.26	1.16
bisexual/queer	10	3.17**	0.84	Sexuality	2.47**	1.15

Qualitative Data Analysis

The students in this study answered two open-response questions during data collection (refer to Appendix D). Not all qualitative data could be analyzed given the scope and objectives of this study. Instead, only the responses from students who are less represented in the sample (i.e., those with the smallest response rates which cannot be subjected to comparative tests in the quantitative analysis) and those found in the quantitative analysis to be significantly different than the reference group identities. There were $n = 49$ students in the final count for qualitative analysis of the data, (see Chapter 4 for the full description for these 49 students). This data was typed into NVivo software for data management and analysis.

Research Question 3: How do students envision their anxiety and stereotype threat effects as they relate to their self-report measures of anxiety and stereotype threat? To analyze the two questions, the specially selected students' responses were segmented according to core themes inspired by the research question (Appendix I; LeCompte et al., 1993). Core themes were responses around emotions or similar constructs mentioned in the first question, and identity related experiences in the second question. Next, I implemented line-by-line open coding of each response to break up the data into smaller pieces within the two segments (Corbin &

Strauss, 2015). These codes were then subjected to thematizing within analytic induction (LeCompte et al., 1993). This method of analytic induction was chosen because the purpose of this research question is to tell the stories of the students experiencing the most stereotype threat and anxiety, which supports the ability to give a more full and universal explanation, as opposed to a "probabilistic" one (LeCompte et al., 1993). In this way, the qualitative data were used as one strategy to more fully explain quantitative data that, according to a tenet of QuantCrit, cannot speak for itself (Castillo & Gilborn, 2022). As an additional piece of analysis in alignment with the tenets of QuantCrit, I qualitatively analyzed each of these students' anxiety and stereotype threat responses. In particular, I looked for patterns in their responses and when a student answered a stereotype threat subscale differently than the other subscales, created postulates for why they may have answered questions in that way. I adopted this strategy because an overall pattern was noticeable for students who (1) were not experiencing stereotype threat and (2) liked to answer all questions at the extreme values of the Likert-type scale. For the qualitative analysis of this quantitative data, I only included the students already in the qualitative data analysis (for the same reasons as selecting them for qualitative data analysis in the first place) who had provided an email address (for member checking of the analysis of their qualitative data) and analyzed their responses, keeping in mind the typical response (i.e., a response we might expect from the population of reference for that question) and their typical response (e.g., some students chose to answer all questions at the midpoint of the scale except for a few questions). I also analyzed these patterns for all eight items of the originally collected subscales, even though only four to six items were used in each subscale in the quantitative data analysis. Part of this qualitative analysis of quantitative data offered insights into why certain items were not internally consistent with the other items for quantitative analysis.

Trustworthiness. Trustworthiness of this analysis is at risk due to a single researcher taking it on. To enhance trustworthiness, I sought the help of one colleague for triangulation based on my coding procedures on a sample of the students' responses. The colleague was selected based on her previous experience conducting qualitative research. This triangulation process included a discussion about nuance between differing codes. I was not concerned with the interrater reliability at the beginning of the comparison discussion; rather we co-constructed the final version of the codebook resolved at 100% interrater reliability. This triangulation process was conducted on 20 student responses. While this number seems like a large number of participants, I make note that their responses were short due to modality of response and time constraints of data collection.

Additionally, the design of this portion of the study is to minimize trustworthiness issues by "deviant case analysis" – as a way to more deeply understand the students which may otherwise fall behind a veil of quantitative data. In addition to this deviant case analysis, analyzing students from groups that are significantly different than the reference identity groups was necessary to ensure trustworthiness of the quantitative data as a tenet of QuantCrit tells us that numbers are not neutral. The qualitative data for these groups give a fuller understanding about the quantitative analysis.

I allowed for full anonymity of student responses to increase full participation in the study. This created a challenge to trustworthiness as member checking of the participants would mean that students were asked to identify themselves. Balancing a need for member checking with the need for anonymity, the identity survey included an optional line for their email address if they were willing to be available for clarifications on their responses in the qualitative data analysis process. I emailed all 13 students who provided email addresses and were included in

the qualitative data analysis, provided a written summary of their responses and a short analysis of these responses, and asked if the analysis sounded reasonable or if there is anything they would like to add or modify. The students were given a deadline of three weeks from my email to respond with their thoughts.

Integration of Quantitative and Qualitative Data

This mixed methods study had a large amount of data: math assessment scores, stereotype threat scores, anxiety scores, identity survey responses, and open responses to written questions. In the interest of avoiding confusing visual displays (McCrudden et al., 2021), only one joint display is used in Chapter 5 and includes concise and clear data.

Non-joint displays will be used in Chapters 4 and 5 to discuss the results of the quantitative and qualitative portions separately, so this information need not be repeated unnecessarily in a joint display. A table for complementarity will be included to relate summaries of the quantitative analyses alongside the qualitative results and exemplar quotes which relate the two (McCrudden et al., 2021).

Research Question 4: How do the quantitative results on the relationship between anxiety and stereotype threat and qualitative results on perceived relationships between anxiety and stereotype threat combine to corroborate, extend, or challenge previous research and the typical classroom culture? Besides a joint display, the qualitative data is used to explain outliers or unexplained quantitative results. These integrations combine and reveal challenges to previous research and the typical classroom culture. The integration of quantitative and qualitative data provides a deeper understanding of stereotype threat and anxiety for the students in this study.

Summary

In Chapter 3, I have outlined a mixed methods study which aims to answer two quantitative questions revolving around the relationship between stereotype threat and anxiety, one qualitative question revolving around certain student perceptions of these relationships, and a mixed methods question to combine the quantitative and qualitative data to challenge the results of previous research and classroom norms (see Figure 2 for a flowchart of these procedures). Taken together, answering these research questions gives us a deeper understanding of the relationship between stereotype threat and anxiety.

Chapter 4: Results

In this chapter, I will discuss the results of the mixed-methods study introduced and outlined in the previous three chapters. This chapter is organized into three sections. The first section addresses the first two research questions, which includes a more detailed subsection of descriptive statistics for the full sample and results of quantitative analyses. The first section also includes a more detailed subsection of descriptive statistics for the qualitative sample. The second section outlines the themes from the qualitative analysis. The third section will address the last research question, which includes the mixing of quantitative and qualitative results, a qualitative look at some of the quantitative results, and a joint display of the mixed data.

Quantitative Results

Descriptive Statistics

Missing Data. In the complete data set, there is some amount of missing data. There were no achievement anxiety or stereotype threat survey items with more than 5% data missing. The income-related and sexuality-related identity questions were missing 23.3% and 8.6% of responses, respectively. Additionally, students age in years and gender identity were missing less than 5% of responses. Identity-related statistical tests will employ listwise deletion. As a result, there are a varying number of participants included in these tests to account for this missing data. It is not appropriate to guess what their identity would have been in these cases.

In the cases of missing item responses for achievement anxiety or stereotype threat survey items, I performed Little's Missing Completely At Random (MCAR) Test to test assumptions about the missing data mechanism. Results revealed insufficient evidence to reject the null hypothesis that data were MCAR, $\chi^2(201, 116) = 206.94, p = .37$. Because this test was not significant and there is not a reason to believe that this data was missing for any systematic reason, I performed

Estimated Marginal Means for data replacement in SPSS to replace the missing data (Graham, 2009). To perform a sensitivity test of this data replacement method, I also performed and will report all the following statistics using listwise-deletion and note any differences in the results.

Descriptive statistics are presented in Table 10. The descriptive statistics demonstrate that skewness fell within normal ranges, between -2 and $+2$, and kurtosis fell mostly within normal ranges, between -7 and $+7$ (Kim, 2013). The Shapiro-Wilk test, however, was significant for each construct, indicating that the outcome variables significantly deviated from normality. Taken together, I used Spearman's Rank Correlation as a nonparametric test for relationships between constructs to answer the first part of the quantitative research questions, but I also performed a sensitivity analysis by checking the parametric test of Pearson's Correlation Coefficient, and any significant correlations were followed up with regression analyses.

Table 10

Descriptive Statistics for Constructs of Interest

Construct	*N*	Mean	*SD*	Min	Max	Skewness*	Kurtosis**	S-W***
Math Confidence	116	4.96	1.88	1	9	−0.39	−0.13	.94
Math Importance	116	6.36	2.04	1	9	−0.55	−0.57	.92
Test Score	116	2.55	1.66	0	7	0.87	0.58	.91
Last Assessment Score	88	72.25	18.3	0	100	−1.10	2.38	.94
Achievement Anxiety	116	2.99	1.28	1	7	0.69	0.24	.96
Gender-Based ST	116	2.91	1.48	1	7.25	0.73	0.05	.93
Race-Based ST	116	2.89	1.35	1	9	0.90	2.50	.94
Sexuality-Based ST	116	2.32	1.20	1	9	1.87	7.49	.84
Income-Based ST	116	2.58	1.39	1	9	1.52	3.61	.88***

Note: The scale ranges for math confidence, math importance, and each stereotype threat are 1-9 (1=strongly disagree; 9=strongly agree). The scale for Achievement Anxiety is 1 – 7 (1=strongly

disagree; 7=strongly agree). The scale range for Test Score was 0-10. The scale range for Last Assessment Score is 0 – 100. SD = standard deviation. ST= stereotype threat. S-W= Shapiro-Wilk
*The Std. Error of all Skewness statistics is between 0.23 and 0.26
**The Std. Error of all Kurtosis statistics is between 0.45 and 0.51
*** Significant at $p < 0.001$

Research Question 1: To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety?

Correlations. A correlation matrix is presented in Table 11 with the gender-, race-, sexuality-, and income-based stereotype threat subscales and achievement anxiety using Spearman's Rank Order Correlation. As expected, there is a significantly positive correlation between achievement anxiety and gender-based stereotype threat, $r = .30, p < .01$; and income-based stereotype threat, $r = .23, p = .01$. Additionally, there is a marginally significant positive correlation between achievement anxiety and sexuality-based stereotype threat, $r(114) = .17, p = .07$. A sensitivity analysis with Pearson's correlation showed that all of these relations were statistically significant ($p < .01$), along with a marginally significant positive correlation between achievement anxiety and race-based stereotype threat, $r(114) = .18, p = .06$. An additional sensitivity analysis with listwise deletion instead of Estimated Means showed similar results. I also note that the four types of stereotype threat in this study were all significantly correlated with each other ($p < .01$).

Table 11

Spearman's Rank Correlation Coefficients

Variable	Achievement Anxiety	Gender-Based ST	Race-Based ST	Sexuality- Based ST
Gender-Based ST	$.30*$	–	–	–
Race-Based ST	$.10$	$.53*$	–	–

Sexuality-Based ST	$.17 ***$	$.49 *$	$.56 *$	–
Income-Based ST	$.23 **$	$.58 *$	$.63 *$	$.56 *$

Note: Sensitivity using listwise-deletion did not produce different results. Sensitivity using Pearson's Correlation Coefficient showed that all the above significant (or nearly significant) relationships at various levels are significant at $p < 0.01$ and the correlation between achievement anxiety and race-based stereotype threat is nearly significant with $p = .06$. ST= stereotype threat.
$* p < .01$
$** p < .05$
$*** p < .10$

In the interest of checking against the typical prerequisite of stereotype threat occurrence (high Math Identification; Steele, 1997), a correlation matrix can be found in Table 12 with the gender-, race-, sexuality-, and income-based stereotype threat subscales; math confidence; and math importance using Spearman's Rank Order Correlation. As I might expect, due to previous research in positive correlations between utility value and self-efficacy (i.e., confidence that you can succeed; Eccles, 2007), there is a significantly positive correlation between math confidence and math importance, $r = .40, p < .001$. Additionally, there is a significant negative correlation between math confidence and achievement anxiety, $r = -.33, p < .001$. None of the four types of stereotype threat featured in this study, however, show a significant correlation with either math confidence or math importance. A sensitivity analysis with Pearson's correlation showed that the relationship between confidence and importance remained statistically significant ($p < .001$). An additional sensitivity analysis with listwise deletion instead of Estimated Means showed similar results.

Table 12

Spearman's Rank Correlation Coefficients

Variable	Math Confidence	Math Importance

Math Importance	$.40*$	$-$
Achievement Anxiety	$-.33*$	$.03$
Gender-Based ST	$-.12$	$-.11$
Race-Based ST	$-.09$	$-.14$
Sexuality-Based ST	$-.06$	$-.11$
Income-Based ST	$-.20$	$-.08$

Note: Sensitivity using listwise-deletion did not produce different results. Sensitivity using Pearson's Correlation Coefficient also did not produce different results. ST= stereotype threat.
$* p < .01$

Predictive Relationships. Given the above-mentioned correlations that the previous analysis detected, simple linear regression was used to test if each type of identity-based stereotype threat significantly predicted achievement anxiety. The overall regression for gender-based stereotype threat was statistically significant ($R^2 = 0.08, F(1, 114) = 10.07, p < .01$). Results revealed that gender-based stereotype threat significantly predicted achievement anxiety ($\beta = 0.29, p < .01$). That is, for every one standard deviation unit increase in gender-based stereotype threat, there is an estimated 0.29-unit increase in achievement anxiety. A sensitivity analysis with listwise deletion instead of estimated means did not have results that would warrant separate analyses (see Appendix J).

The overall fitted regression model for whether race-based stereotype threat predicted achievement anxiety was marginally significant ($R^2 = 0.03, F(1, 114) = 3.71, p = .06$). Results revealed that race-based stereotype threat marginally predicted achievement anxiety ($\beta = 0.18, p = .06$). That is, for every one standard deviation unit increase in race-based stereotype threat, there is an estimated 0.18-unit increase in achievement anxiety. A sensitivity analysis with listwise deletion instead of estimated means was not necessary since there was no missing data in these two scales initially.

The overall fitted regression model for whether sexuality-based stereotype threat predicted achievement anxiety was statistically significant ($R^2 = 0.06, F(1, 114) = 7.03, p < .01$). Results revealed that sexuality-based stereotype threat significantly predicted achievement anxiety ($\beta = 0.24, p < .01$). That is, for every one standard deviation unit increase in sexuality-based stereotype threat, there is an estimated 0.24-unit increase in achievement anxiety. A sensitivity analysis with listwise deletion instead of estimated means did not have results which would warrant separate analyses (see Appendix J).

The overall fitted regression model for whether income-based stereotype threat predicted achievement anxiety was statistically significant ($R^2 = 0.07, F(1, 114) = 8.79, p < .01$). Results revealed that income-based stereotype threat significantly predicted achievement anxiety ($\beta = 0.27, p < .01$). That is, for every one standard deviation unit increase in income-based stereotype threat, there is a 0.27-unit increase in achievement anxiety. A sensitivity analysis with listwise deletion instead of estimated means did not have results which would warrant separate analyses (see Appendix J).

Research Question 2: To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)?

Correlations. There is a marginally significant negative correlation between achievement anxiety and the math assessment score found using Spearman's Rank Order Correlation, $r = -.16, p = .08$. A sensitivity analysis with Pearson's correlation showed that this relationship was slightly less significant ($p = .12$). An additional sensitivity analysis with listwise deletion instead of Estimated Means was not necessary as no data had been missing for these two variables.

In the interest of comparing the test on this day to other math assessments, I used Spearman's Rank Order Correlation to compare their most recent in-class math assessment score and achievement anxiety. There is a marginally significant negative correlation between achievement anxiety and the recent test score, $r = -.19, p = .08$. A sensitivity analysis with Pearson's correlation showed that this relationship was slightly more significant ($p = .06$). An additional sensitivity analysis with listwise deletion instead of Estimated Means was not necessary as the recent test data had been missing in such a way that it was not replaceable and achievement anxiety had not been missing any data.

I used Spearman's Rank Order Correlation to compare their most recent in-class math assessment score and the math assessment score on the day that data was collected. There is no statistically significant correlation between the two test scores, $r = .05, p = .64$. A sensitivity analysis with Pearson's correlation reached similar conclusions ($p = .54$). An additional sensitivity analysis with listwise deletion instead of Estimated Means was not necessary as the recent test data had been missing in such a way that it was not replaceable, and the math test score had not been missing any data.

Predictive Relationships. I used simple linear regression to test if achievement anxiety significantly predicted the math performance on the day that data was collected. The overall fitted regression model for whether math performance predicted achievement anxiety was not significant ($R^2 = 0.02, F(1, 114) = 2.46, p = .12$). I did not find that achievement anxiety significantly predicted the math score ($\beta = -0.15, p = .12$). A sensitivity analysis with listwise deletion instead of estimated means, again, was not necessary.

Simple linear regression was also used to test if their most recent math assessment predicted their achievement anxiety on the day of this assessment – note that the predictive

relationship being assessed is now reversed, since the achievement anxiety on the day the data was collected would not predict a previous day's assessment score. The overall fitted regression model for whether the recent math assessment performance predicted achievement anxiety was marginally significant ($R^2 = 0.03, F(1, 86) = 3.78, p = .06$). It was found that their previous math score marginally significantly predicted their achievement anxiety ($\beta = -0.21, p = .06$). That is, for every one standard deviation unit increase in their previous math assessment score, there is a 0.21-unit decrease in their achievement anxiety on the day data was collected. A sensitivity analysis with listwise deletion instead of estimated means, again, was not necessary.

In this study, I found that gender-, sexuality-, and income-based stereotype threats predict anxiety to the $p < .05$ level or lower and race-based stereotype threat predicted anxiety at $p = .06$. Recall that I do not reject the result of race-based stereotype threat's prediction of achievement anxiety, because these results may still be practically significant.

Preliminary Quantitative Analyses for Qualitative Sample Selection

I conducted two one-way ANOVAs on the full sample of students to compare the effect of gender identity on (a) gender-based stereotype threat and (b) achievement anxiety, respectively. A one-way ANOVA revealed that there was a statistically significant difference in gender-based stereotype threat between at least two groups ($F(2, 112) = 3.09, p < .05$). Games-Howell for multiple comparisons found that the mean value of gender-based stereotype threat was significantly different between men ($M = 2.49$) and women ($M = 3.19$), $p = .02$, $95\%\ C.I. = [-1.29, -0.10]$. There were no statistically significant differences between men and trans students ($p = .93$) or women and trans students ($p = 1.00$). Another one-way ANOVA revealed that there was not a statistically significant difference in achievement anxiety between at least two groups ($F(2,112) = 1.24, p = .29$). As the gender-identity group with the most

gender-based stereotype threat and as the gender-identity group with previous research in stereotype threat for mathematics (Spencer et al., 1999), women were selected for qualitative analysis.

I performed two one-way ANOVAs on the full sample of students to compare the effect of racial identity on race-based stereotype threat and on achievement anxiety. A one-way ANOVA revealed that there was a statistically significant difference in race-based stereotype threat between at least two groups ($F(4, 107) = 3.11, p = .02$). Games-Howell for multiple comparisons found that the mean value of race-based stereotype threat was significantly different between white students ($M = 2.57$) and Black students ($M = 3.58$), $p = .04, 95\%\ C.I. = [-1.97, -0.05]$. There was also a nearly significant difference between Native American students ($M = 2.41$) and Black students ($M = 3.58$), $p = 0.097, 95\%\ C.I. = [-2.49, 0.15]$. There were no statistically significant differences between white students and Asian students ($p = .34$), white students and Native American students ($p = .99$), white students and Latine students ($p = .66$), Black students and Asian students ($p = 1.00$), Black students and Latine students ($p = .92$), Asian students and Native American students ($p = .31$), Asian students and Latine students ($p = .97$), or Native American and Latine students ($p = .60$). Another one-way ANOVA revealed that there was not a statistically significant difference in achievement anxiety between at least two groups ($F(4,107) = 0.28, p = .89$).

As a sensitivity analysis of the previous one-way ANOVA with the hopes of addressing the complexities of racial identity for students who identify as more than one race (17% of the full sample), I conducted a multiple regression analysis to confirm the ANOVAs from the previous paragraph – with the six racial-identity variables (white, Black, Native American, Asian, Latine, and Middle Eastern) combining to predict race-based stereotype threat, but not

achievement anxiety. I confirmed that these six racial-identity variables explained a significant amount of variance in race-based stereotype threat ($F(6,105) = 2.90, p = .01,\ R^2 = 0.14,\ R^2_{\text{Adjusted}} = 0.09$). I also confirmed that these six racial-identity variables did not explain a significant amount of variance in achievement anxiety ($F(6,105) = 0.46, p = .84,\ R^2 = 0.03, R^2_{\text{Adjusted}} = -0.03$). As the racial-identity group with the most race-based stereotype threat, and the group with previous research in stereotype threat in academics (Steele & Aronson, 1995), Black students were selected for qualitative analysis.

I conducted two one-way ANOVAs on the full sample of students to compare the effect of sexuality on sexuality-based stereotype threat and on achievement anxiety. A one-way ANOVA revealed that there was a statistically significant difference in sexuality-based stereotype threat between at least two groups ($F(2, 103) = 5.59, p < .01$). Games-Howell for multiple comparisons found that the mean value of gender-based stereotype threat was marginally significantly different between bisexual/queer students ($M = 2.47$) and gay students ($M = 5.00$), $p = .08, 95\%\ C.I. = [-5.76, 0.69]$. There were no statistically significant differences between straight students and queer/bisexual students ($p = .85$) or straight students and gay students ($p = .15$). Another one-way ANOVA revealed that there was not a statistically significant difference in achievement anxiety between at least two groups ($F(2,103) = 1.36, p = .26$). As the sexuality-identity group with the most sexuality-based stereotype threat, and the one which has previous research in stereotype threat in mathematics (Raymond, 2014), gay students were selected for qualitative analysis.

I performed two one-way ANOVAs on the full sample of students to compare the effect of socioeconomic status on income-based stereotype threat and on achievement anxiety. A one-way ANOVA revealed that there were no statistically significant differences in income-based

stereotype threat based on socioeconomic status ($F(3,85) = 1.39, p = .25$). Another one-way ANOVA revealed that there was not a statistically significant difference in achievement anxiety between at least two groups ($F(3,85) = 0.79, p = .51$). Socioeconomic status in this case was identified by adding up the number of boxes selected for financial resources to pay for college. Given these results, no students were selected for qualitative analysis based on their socio-economic status.

Descriptive statistics in Table 13 show the smaller subset of students included in the qualitative data analysis. As described in Chapter 3, I chose students for qualitative analysis who (1) had open-response data to analyze and (2) experienced significantly more stereotype threat or anxiety within a particular identity group as compared to other identity groups. In lieu of experiencing more stereotype threat or anxiety than their peers, a student may have additionally been selected for qualitative analysis if they were multi-racial or if their identity had to otherwise be aggregated. Multi-racial students were chosen because quantitative analysis is more limited in its ability to acknowledge multiple racial identities than for the other identities in this study. Students who would typically be overly aggregated, such as the student who identified as Middle Eastern or the student who identified as Gender Fluid, were included to give them an additional opportunity for their voice to be heard. These students might typically be included in a larger identity group or be excluded from a quantitative analysis. There were two additional students included besides those in Table 13 and besides those included in the quantitative analysis. These two students did not disclose their various identities, and one did not finish the surveys, but both had included substantial open-response answers.

Table 13

Descriptive Statistics for Populations Qualitatively Analyzed

Construct	N	Relevant* ST Mean	Relevant* ST SD	Anxiety Mean	Anxiety SD
Women	41	3.52	1.70	3.29	1.33
Black students	11	3.73	1.53	3.14	0.90
Gay students	1	5.50	-	4.67	-
Multi-racial students	8	3.06	0.98	2.52	1.37
Identity Aggregated	8	-	-	3.04	1.09

Note: The scale ranges for each stereotype threat scale are 1 – 9 (1 = strongly disagree; 9 = strongly agree). The scale for Achievement Anxiety is 1 – 7 (0 = strongly disagree; 6 = strongly agree). ST= stereotype threat. SD= standard deviation. Identity Aggregated means that these students were included in another category for the one-way ANOVAs. This included the students who identified as trans male, transman, gender fluid, Cherokee, Filipino, Indian, Middle Eastern, and Vietnamese + straight/bicurious.
* The Relevant ST Mean and SD are those which are related to the identity in question. For example, the Relevant ST for women is gender-based stereotype threat.

Qualitative Results

Research Question 3: How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task?

For the 49 students selected for qualitative data analysis, I began with creating a profile for each student. This profile had some selections from their quantitative data, their identities, and their responses to the open-response questions – see Appendix K for an example. I uploaded the 49 profiles to NVIVO Software and used open coding on the open-response questions. Initially, there were 64 separate codes. I asked a colleague to spend time with 20 of the profiles and code them herself. This colleague has previous experience in open coding of qualitative data and was provided with a triangulation protocol (see Appendix L) which asked her to code with an eye

toward the spirit of the questions – responses based on emotions and identity – but to include any other codes which were notable. For convenience, the open-response questions are provided below:

1. We acknowledge that survey scores may not give you the opportunity to express your full experiences. Is there anything else you'd like the researchers to know about your emotional experiences during the math assessment and your performance on it?
2. Do you think that your experience with the math assessment is typical for someone of your identity and experience? Please feel free to elaborate with as much detail as you would like the researchers to have about your true feelings.

We initially had 75% interrater reliability. We initially disagreed on some codes, but not because we disagreed about the meaning of the statements from the students. That is, there were codes that I had that she did not, and vice versa. After discussion, we determined that all codes were necessary for a full picture of the students' statements, so the five additional codes created by my colleague were added into the 20 profiles she was given for review, and I re-coded the other 29 profiles with the new codes in mind. There were then 69 distinct codes used across the 49 profiles. See the full codebook in Appendix M.

After determining the 69 codes for the 49 students in the qualitative portion of the study, I organized the coded data into themes. As this thematic analysis is based on the data provided by students, and not explicitly created based on the theoretical lens in this study, these themes were created inductively (J. W. Creswell & Poth, 2018). There was a total of 11 themes which covered a range of one student to 21 students in each theme. Because the questions were open-ended in a written survey with no follow-up questioning, some codes and some themes are not relevant to this qualitative research question. In the following sections, I outline the 9 most relevant themes from this group of students, including examples of their responses which embody the theme. The themes are organized from most-coded to least-coded number of students within each theme.

In the described themes below, students are identified by an ID number created through the data collection process (e.g., 2G or 1E). Additionally, gender, race, and sexuality are provided for each student, and listed in the same way that they wrote them in the open-response identity survey. Some students did not disclose their sexuality, in which case only their gender and racial identities are included.

Theme 1: Explanations for Performance or Emotions ($n = 21$). Some students felt the need to explain their performance or explain the emotions they felt during their performance. These explanations included references to the administration of the assessment itself, including references to the limited timeframe of the assessment ("I was definitely nervous especially since there was limited time on problems . . .", 2G – white woman) and not being prepared ahead of time for the assessment ("I was more nervous because I didn't know that this was happening today." 1E – gay, white and Black, transman). Explanations also revolved around the mathematical abilities of the students. For example, students might have felt like they were less educated (". . . I grew up/went to school in an underfunded area. So I feel like I got less of an education", 14J – straight, Black woman) or that they otherwise were not skilled ("I didn't know most of the question[s] but I tried my best and that's what matters", 7A – straight, Asian: Indian woman). Student 7A mentions that it is their attempt that matters. Other explanations also included a reference to effort as part of performance. For example, Student 2L (straight, Native American woman) said "I think it varies from person to person and how much they attend class." Taken together, students might feel the need to explain away their performance or emotions due to administration of an assessment, their abilities, or their efforts put into the assessment.

Theme 2: Negative Emotions ($n = 20$). When students brought up an emotion, the most frequent valence was negative – e.g., anxiety, nervousness, stress, or panic. Some students

discussed their negative emotions in terms of this assessment ("It was just scary. I felt unprepared and stupid", Student 2C – straight, white woman), while others alluded to – or outright named – struggles with testing anxiety ("Math assessments bring me utter stress", Student 6I – straight, white woman). Other students specifically identified a neutral emotion on this assessment, but indicated that if the circumstances had been different, then they would have felt more stressed. For example, Student 1C (heterosexual, white/Hispanic woman) said "Because this assessment had low stakes, it did not invoke a nervous response for me. Had this been an exam, I would be nervous almost to the point of sweating." Students who have negative emotions might have some coping mechanisms for their anxiety ("I just usually panic when I know that there's an assessment nearing, but I find ways to calm myself down before I start", Student 1D – heterosexual, Black woman) or work to normalize their experience ("I feel like everyone has anxiety when it comes to math", Student 4F – heterosexual, Black male). In summary, students felt negative emotions on this assessment, may typically have negative emotions during assessments, find ways to cope with their negative emotions, or perceive that it is normal to experience negative emotions in math settings.

Theme 3: It's Not About Identity ($n = 18$). Some students mentioned that identity does not play a role in their academic success. Although the questions asked about their emotions and whether their experience (not their performance) were typical for students sharing their identity, these students brought up that they "feel identity has nothing to do with ability" (Student 11B – bisexual, white woman) or that "identity in my belief does not have much to do with it" (Student 12M – Latino, straight Trans male). Some of these students had alternatives for what could contribute to differing abilities and performance in mathematics, such as grading biases (". . . unless the professor grading said math assignment is an idiot, scores will reflect said

knowledge accurately", Student 2C – straight, white woman), understanding ("Gender has nothing to do with it. It is about being able to fully comprehend the teachers," Student 1F – Black, heterosexual male), access to resources (". . .having access to good math classes would most likely make an impact", Student 2G – white woman), study habits ("Everyone comes from a different background. It is all about how you apply yourself", Student 2G – white woman), or added stress or anxiety ("I don't think identity matters, but if someone has bad anxiety, they may feel similar", Student 6I – straight white woman). One student in particular, who did not give any answers to the identity questions, and stopped filling out the survey partially through the stereotype threat-related questions used the open-response space to say:

> "I didn't fully do the survey because race, gender, and sexuality literally have nothing to do with math and how it is done. We are human. We all have different minds. It does not mean any of the stuff you asked in this survey would do any different. This type of study is why it is an issue. Because you all make it an issue. (Student 4J).

Taken together, students who specified that they don't believe that identity has anything to do with math ability or performance might also bring up grading biases, resources, studying, emotions, or why they find thinking about identity and performance at the same time to be problematic.

Theme 4: Identity Comparisons ($n = 18$). To the question that asked if they think that their experience with math assessments is typical for someone of their identity and experience, some students were comfortable making comparisons to others within or outside of their identity group, though these comparisons varied. Those who went beyond saying how normal their experience was talked about their emotions ("someone who is a little more anxious than others and those who care a little about their abilities would probably feel the same as I did", Student 3C – straight, Native American woman), available resources ("Yes because I grew up/went to

school in an underfunded area. So, I feel like I got less of an education", Student 14J – straight, Black woman), previous math courses ("Yes. As someone who was put into 'gifted' math classes growing up well before I was actually ready, I'm sure others with the same experience may perform similarly", Student 4I – heterosexual, Black woman), or experiences within an identity ("I believe so. Others who are female tend to, from what I observe, have negative experiences in math class", Student 8A – heterosexual, Native American woman). A couple of students brought up specific stereotypes about members of their race, either positive stereotypes ("Indian people are often perceived as people that are good at math. I would say that math assessment may be very common for someone of my ethnicity", Student 7A – straight, Asian: Indian woman) or negative stereotypes ("I feel like because of my race, people don't automatically assume I'm smart", Student 3B – straight, African American woman). Positive stereotypes may also lead to particular inter-community expectations for performance. For example, Student 3G (heterosexual, Asian/white male) felt less worried than others within his identity, considering that "there are high expectations on school grades for people in my culture". Comparisons to others who have similar identity might include those about emotions, resources, previous experiences, identity, stereotypes, or expectations.

Theme 5: Neutral Emotions and Experiences ($n = 14$). When students indicated a neutral experience on the assessment, they often cited that the assessment felt very low stakes. For example, Student 5L (heterosexual, white woman) said "since this was not for a grade, I did not feel pressure/anxiety to get the correct answer." Other students having neutral experiences indicated that this was the typical experience, either typical for someone of their identity ("I think my experience was typical for someone of my background," Student 1C – heterosexual, white/Hispanic woman) or typical for their own experiences ("Yes, I thought it was a good

mixture of math problems," Student 1L – straight, Black woman). A few students also wanted to specify that they did not experience emotional stressors during the assessment ("None, wasn't worried or nervous. It was just an assessment," Student 15N (straight, Native American/white woman). A neutral experience might also include feeling that the test was easy ("Yes, for someone that gets math as much as me this would be easy," Student 2K – straight, Asian-Filipino male) or that they performed well ("I think I did fine," 3G – heterosexual, Asian/white male). Taken together, students who had neutral emotions and experiences may have felt the assessment was low stakes, had a typical experience, did not have emotional stress, and felt that they performed well.

Theme 6: Math Ability ($n = 13$). Some students thought of their emotions and experiences in terms of their mathematical abilities. For some, this meant having a part of their identity include an academic aspect, either that they are good at math – like Student 2K (straight, Asian-Filipino male) from Theme 5 who said "Yes, for someone that gets math as much as me this would be easy," – or that they are not good at math – like Student 5D (straight, white woman) who said "No, I have never enjoyed math or been good at it so I think someone who is better at math would have a different experience". Others may not indicate that it is part of their identity, but that they do find math to be challenging ("Somewhat, math is somewhat difficult for me", Student 2I – straight, white woman). Math ability concerns might be general or specific to a student's identity.

Theme 7: Changes During the Assessment ($n = 6$). A few students talked about changes to their experience during the assessment or surveys. These changes included feeling emotionally better about the assessment as it progressed ("At the beginning I was nervous about not be able to answer some questions, but after we started and I just went for it, it was fine",

Student 3C – straight, Native American woman), feeling a physical symptom crop up ("I don't think it was because I was focusing too hard, but I did give myself a headache," Student 3E – bisexual, white woman), learning from the test (". . . even though some may be wrong, it was a learning experience," Student 8H – Black, Asian, and white woman), and giving up on the test ("I gave up quickly because I knew I would not be able to solve most of the equations correctly," Student 9L – straight, Latina woman).

Theme 8: Positive Emotions and Experiences ($n = 2$). While very few students mentioned explicitly that they had a positive experience during the assessment, the scope of this study suggests that these two students' experiences are worth mentioning within a theme. Specifically, by including all the ways that students in the qualitative subsample envision their experiences in the math task – not only those related to anxiety. One student simply stated, "I love math," (Student 2K – straight, Asian-Filipino male), and the other said "I didn't get enough time to finish, but I enjoyed figuring out how to solve the problem, knowing that the test was optional," (Student 5H – straight/bicurious, Black, white, and Vietnamese woman).

In summary, qualitative themes in this study ranged from students talking about their emotions (positive, neutral, or negative), their identities as compared to others, explanations about their performance, and explicit rejection of the idea that identity relates to experiences at all. In the next section, I look at the mixture of quantitative and qualitative results, including some qualitative interpretation of quantitative data.

Mixed Results

Research Question 4: How do the quantitative results on the relationship between anxiety and stereotype threat and qualitative results on perceived relationships between anxiety and stereotype threat combine to corroborate, extend, or challenge previous research and the typical classroom culture?

As discussed in Chapter 3, mixing the quantitative and qualitative data largely includes looking at the results outlined previously alongside each other. Therefore, Table 18 reflects a joint display, which includes summaries of the quantitative analyses in the first column, relevant qualitative results in the second column, and an exemplar quote which relates the quantitative and qualitative results in the third column.

As Table 18 reveals, a quantitative result from this study is that gender-based stereotype threat positively predicted anxiety with a small effect size ($\beta = 0.29$). While there was not a lot of mention in open-ended responses of stereotype threat or stereotypes and gendered experiences in relation to anxiety, one student mentioned that she has had negative experiences in mathematics in her background (including gender), potentially leading to her current insecurities.

Another quantitative result from this study is that race-based stereotype threat positively predicted anxiety with a small effect size ($\beta = 0.18$). Like gender, there were not a lot of mentions of race and anxiety. However, one student mentioned that she is not often assumed to be smart based on her race but writes off her nervousness during exams as testing anxiety.

In terms of sexuality-based stereotype threat, I found in this study that it predicted anxiety with a small effect size ($\beta = 0.24$), but only one student in the qualitative portion of the study was chosen due to his sexuality, and he did not reference his sexuality in regards to his nervousness on the day that data was collected.

In terms of income-based stereotype threat, the quantitative results showed that it predicted anxiety with a small effect size ($\beta = 0.27$). Students who mentioned their finances in some way, often referenced a mediator between income and anxiety to be additional resources for success. One student in particular feels that it is typical for people who grow up in poverty to do less well in math (see Table 14).

The math assessment score in the study was not predicted by anxiety, but their most recent math assessment score in class predicted anxiety with a small effect size ($\beta = -0.21$). In the qualitative portion of the study, many students referenced being nervous about assessments in general, but that this one did not cause as much stress because it was not for a grade and didn't matter.

Table 14

Joint Display of Quantitative and Qualitative Results

Quantitative Result Summary	Relevant Qualitative Result	Exemplar Quote (See Appendix D for Open-Response Questions)
Gender-based stereotype threat predicts anxiety.	Some students think that their experience is typical for someone in their gender identity group.	"I believe so. Others who are female tend to, from what I observe, have negative experiences in math class. I also experienced poor math education in high school. This may also affect me negatively today. Overall, I have a neutral experience in math learning. Insecurities may stem from my sex and mathematics background." – 8A (heterosexual, Native American woman)
Race-based stereotype threat nearly significantly predicts anxiety.	Some students are aware of race-based negative stereotypes.	"I feel like because of my race, people don't automatically assume I'm smart." . . . "I sometimes get a little nervous taking any form of quiz, test, exam, etc. … More than likely just test anxiety." – 3B (straight, African American woman)

Sexuality-based stereotype threat predicts anxiety.	Their performance or emotions were due to not being prepared for the assessment ahead of time.	"I was more nervous because I didn't know that this was happening today." – 1E (gay, white and Black transman)
Income-based stereotype threat predicts anxiety.	Their performance or emotions are a consequence of being less educated in mathematics due to financial resources.	"People who also grew up in poverty or in a small town education system are not usually people who excel in math. My social location is no fault of my own; I do try in my math class." . . . (Regarding their emotional experiences) "I wish I'd had more time." – 2H (white and Cherokee woman).
The math assessment score in the study did not predict anxiety.	They refer to the fact that this assessment was low stakes and not for a grade, which is why they had neutral emotions or had no emotional stress/anxiety.	"Since this was not for a grade, I did not feel pressure/anxiety to get the correct answer." – 5L (heterosexual, white woman).
Their most recent math assessment score nearly significantly predicted anxiety.	They may not have felt anxious about this assessment, but made it sound like this assessment was the exception to the rule.	"Because this assessment had low stakes, it did not invoke a nervous response for me. Had this been an exam, I would be nervous almost to the point of sweating." – 1C (heterosexual, white/Hispanic woman).

Inspired by my QuantCrit lens, in addition to mixing quantitative and qualitative data in the joint display featured in Table 14, I also conducted a qualitative exploration of the quantitative data (Curley, 2019). That is, QuantCrit necessitates going beyond mere statistical tests in analyzing quantitative data (Gillborn et al., 2018). Additionally, a participatory social-justice design involves the study's participants in a portion of the study itself (J. Creswell & Plano Clark, 2018). Students were not required to provide their name or email address to participate in this study but were allowed to provide their email address "to be contacted later about clarifications on your open-response answers" (see Appendix E). For the students who provided their email address, they could be contacted for approval of the analysis of their data

and clarifications about their responses. Because I had contact information for 13 of the students in the qualitative portion of the study, and could, therefore, involve these students in the analysis process for this qualitative exploration of quantitative data, I took a closer look at the survey responses for these 13 students. Each section below outlines one of these students' survey responses.

Student 1D (heterosexual, Black woman). Table 15 shows the survey responses to all of Student 1Es subscale responses. On this particular assessment, she had fairly low anxiety scores, but mentioned in the open-response questions that she usually feels some panic or anxiety before tests. She also mentioned having a way to cope with this panic ahead of the exam to help her anxiety go away before she begins. She answered as close to the center of the stereotype-threat subscales as possible for many questions, and answered near the extremes of the scale indicating possible feelings of low stereotype threat. For example, she slightly disagrees that her race does not affect perceptions of her ability, and she is neutral about a statement that she often feels that others look down on her because of her race. She also slightly agrees that she doubts others think she has less math ability due to her race.

Table 15

Survey Responses for Mixed Results Analysis of Student 1D

Scale	Responses in Order of Items
Anxiety	2 – 1 – 2 – 3 – 2 – 1
Gender-Based ST	3 – 5 – 7 – 4 – 4 – 3 – 6 – 2
Race-Based ST	3 – 5 – 5 – 5 – 4 – 4 – 3 – 4
Sexuality-Based ST	3 – 4 – 4 – 4 – 6 – 2 – 6 – 2
Income-Based ST	3 – 5 – 5 – 4 – 4 – 3 – 6 – 2

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 1E (gay, white and Black transman). Table 16 shows the survey responses to all of Student 1Es subscale responses. His survey answers indicated a moderate to high level of anxiety on the assessment taken that day, which he indicated in the open-response questions may have been because he wasn't aware of the assessment taking place that day. In questions about how he thinks others perceive his math abilities, he makes some indications that he feels like his gender identity might affect people's perception of his math ability. He also indicates that others may think that he has less math ability as a gay man. He answers neutrally about the way others view him in terms of his racial identity.

Table 16

Survey Responses for Mixed Results Analysis of Student 1E

Scale	Responses in Order of Items
Anxiety	4 – 4 – 3 – 4 – 4 – 3
Gender-Based ST	1 – 1 – 1 – 5 – 2 – 5 – 2 – 5
Race-Based ST	1 – 4 – 4 – 2 – 2 – 2 – 2 – 4
Sexuality-Based ST	1 – 1 – 1 – 5 – 2 – 5 – 3 – 4
Income-Based ST	1 – 1 – 6 – 1 – 4 – 4 – 4 – 4

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 1H (bisexual, white woman). Table 17 shows the survey responses to all of Student 1H's subscale responses. She had some level of anxiety during the assessment given that day, but mostly responded with low levels of stress. In response to questions about how she feels others perceive her math abilities, she strongly agreed to experiencing being stereotyped or unfair bias in evaluation based on her gender identity. This response contrasts the answer for race-, sexuality-, and income-based stereotype threat responses. She also mentioned in her open-

response items that exams typically come with a lot of anger and stress, particularly when she feels that there is a barrier to success. This seems to contradict her survey responses about anxiety but could be more because the typical class assessment is more high stakes than the one involved in this dissertation study.

Table 17

Survey Responses for Mixed Results Analysis of Student 1H

Scale	Responses in Order of Items
Anxiety	5 – 1 – 1 – 6 – 1 – 1
Gender-Based ST	0 – 0 – 0 – 6 – 2 – 6 – 3 – 8
Race-Based ST	0 – 0 – 7 – 1 – 8 – 7 – 7 – 0
Sexuality-Based ST	1 – 1 – 6 – 2 – 2 – 5 – 8 – 2
Income-Based ST	1 – 2 – 6 – 2 – 4 – 2 – 6 – 1

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 1L (straight, Black woman). Table 18 shows the survey responses to all of Student 1L's subscale responses. She did not indicate any anxiety during the assessment given that day. She indicated having some experiences with biased evaluations in mathematics due to her financial status, and neither agreed nor disagreed with some items about feeling stereotyped based on gender and racial identities. In terms of gender, she was neutral-to-in-agreement that people feel she has less math ability as a woman. In terms of her racial identity, she neither agreed nor disagreed that others would think she has less math ability due to her race. She agreed that some people feel she has less math ability due to her race, and she agreed that in math classes people of her race often face biased evaluations from others. She also answered income-based stereotype threat questions in such a way that suggests some stereotyped experiences in that part of her identity (e.g., by endorsing several of these items). This student did not bring up

her identity in her open-response items, so I cannot compare these quantitative responses to her qualitative data.

Table 18

Survey Responses for Mixed Results Analysis of Student 1L

Scale	Responses in Order of Items
Anxiety	1 – 1 – 1 – 1 – 1 – 1
Gender-Based ST	1 – 1 – 1 – 4 – 7 – 4 – 7 – 1
Race-Based ST	1 – 1 – 4 – 5 – 1 – 5 – 7 – 1
Sexuality-Based ST	1 – 1 – 7 – 1 – 7 – 1 – 7 – 1
Income-Based ST	1 – 4 – 3 – 3 – 4 – 6 – 3 – 1

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 2L (straight, Native American female). Table 19 shows the survey responses to all of Student 2L's subscale responses. Based on her strong endorsement of the anxiety items, she experienced quite a bit of anxiety during the assessment that day. She disagrees that women rarely face unfair evaluations in math classes, and slightly disagrees that Native American students face these unfair evaluations. Her answers otherwise indicate very little experience being stereotyped for her gender, race, sexuality, or income. In open-response questions she indicates that experiences vary "from person to person and how much they attend class."

Table 19

Survey Responses for Mixed Results Analysis of Student 2L

Scale	Responses in Order of Items
Anxiety	5 – 5 – 5 – 6 – 6 – 6
Gender-Based ST	0 – 0 – 8 – 0 – 2 – 1 – 8 – 0
Race-Based ST	0 – 0 – 8 – 0 – 3 – 2 – 6 – 1

Sexuality-Based ST	0 – 0 – 8 – 0 – 8 – 0 – 8 – 0
Income-Based ST	0 – 0 – 8 – 0 – 8 – 0 – 8 – 0

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 3B (straight, African American woman). Table 20 shows the survey responses to all of Student 3B's subscale responses. She experienced low-to-moderate levels of anxiety on the assessment that day, which she mentioned in the open-response questions being typical for her on assessments. In terms of gender and sexuality, she answers each question at the lowest end of the scale, regardless of directionality of the question. On her racial identity, she answered most questions at or near the "neither agree nor disagree" mark. In contrast, however, in open-response questions, she mentions that due to her race "people don't automatically assume" that she is smart.

Table 20

Survey Responses for Mixed Results Analysis of Student 3B

Scale	Responses in Order of Items
Anxiety	3 – 3 – 1 – 2 – 1 – 2
Gender-Based ST	0 – 0 – 0 – 0 – 0 – 0 – 0 – 0
Race-Based ST	3 – 1 – 4 – 4 – 0 – 5 – 4 – 5
Sexuality-Based ST	0 – 0 – 0 – 0 – 0 – 0 – 8 – 0
Income-Based ST	4 – 1 – 4 – 4 – 1 – 4 – 7 – 4

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 3G (heterosexual, Asian/white male). Table 21 shows the survey responses to all of Student 3G's subscale responses. He did not experience anxiety about the test that day, but he also indicated through his open-response questions that his lack of anxiety was because the test was not for a grade. In terms of gender, he did not answer questions in a way that suggests

feeling negatively stereotyped by being a man. As an Asian/white student, he expresses that there may be some bias in evaluation for people of his race and that his race does affect the way people think about his math ability. He neither agreed nor disagreed that the test may have been easier for people of his financial status, and he slightly agreed that his financial status does not affect people's perception of his math ability. Upon reflection of these answers, he said:

> "I don't believe someone's financial status reflects their ability to perform well on a test. I do however recognize that students from higher incomes are often able to attend better funded schools, have more access to quality study materials, and have less stress about financial issues that could interfere in their learning. I also understand that schools in lower income areas typically receive less funding for educational materials and more experienced teachers, which in turn is often reflected by lower grades."

Table 21

Survey Responses for Mixed Results Analysis of Student 3G

Scale	Responses in Order of Items
Anxiety	0 – 0 – 0 – 0 – 0 – 0
Gender-Based ST	0 – 0 – 8 – 0 – 8 – 0 – 0 – 0
Race-Based ST	0 – 2 – 8 – 0 – 8 – 8 – 0 – 0
Sexuality-Based ST	0 – 0 – 8 – 0 – 8 – 0 – 8 – 0
Income-Based ST	0 – 4 – 8 – 0 – 8 – 0 – 5 – 0

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 3H (straight, Native American woman). Table 22 shows the survey responses to all of Student 3H's subscale responses. She experienced moderate anxiety on the day of the assessment. In open-response questions, she indicated that the assessment itself caused some confusion, but she felt that other people with the same mathematical experience as her would feel similarly. In terms of feeling stereotyped as a woman in mathematics, she responded that women

face unfair evaluations in math classes and that being a woman affects people's perception of her math ability. She did not indicate feeling stereotyped regarding her race or sexuality but answered closer to the center on questions regarding income, including slightly disagreeing that people of her financial status rarely face unfair evaluations in math classes.

Table 22

Survey Responses for Mixed Results Analysis of Student 3H

Scale	Responses in Order of Items
Anxiety	1 – 4 – 2 – 5 – 3 – 1
Gender-Based ST	1 – 1 – 6 – 5 – 1 – 4 – 6 – 1
Race-Based ST	1 – 1 – 7 – 1 – 7 – 1 – 7 – 1
Sexuality-Based ST	1 – 1 – 7 – 1 – 7 – 1 – 7 – 1
Income-Based ST	1 – 4 – 6 – 2 – 3 – 1 – 6 – 1

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 4K (bisexual, white woman). Table 23 shows the survey responses to all of Student 4K's subscale responses. She experienced a relatively high level of anxiety during the assessment that day. In terms of her math experiences, she did not doubt that others might think less of her math ability due to being a woman, but she neither agreed nor disagreed with statements about facing unfair or biased evaluations and how gender might affect perceptions of her math ability. In the open-response questions, she mentioned that identity does not play a role in math performance, but that identity can affect the stress that a person has. She mentions that unfair evaluations can be avoided by not disclosing stereotyped aspects of her identity. Her answers for race-, sexuality-, and income-based stereotype threat subscales are consistent with each other and answered in such a way to suggest not having stereotyped experiences for those

parts of her identity (i.e., she disagrees with the statement "People of my sexuality rarely face unfair evaluations in math classes.").

Table 23

Survey Responses for Mixed Results Analysis of Student 4K

Scale	Responses in Order of Items
Anxiety	4 – 3 – 5 – 5 – 2 – 3
Gender-Based ST	1 – 1 – 2 – 2 – 4 – 4 – 4 – 2
Race-Based ST	2 – 2 – 6 – 2 – 6 – 2 – 5 – 2
Sexuality-Based ST	2 – 2 – 6 – 2 – 5 – 2 – 6 – 2
Income-Based ST	2 – 2 – 6 – 2 – 6 – 2 – 6 – 2

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 5H (straight/bicurious, Black, white, and Vietnamese woman). Table 24 shows the survey responses to all of Student 5H's subscale responses. She felt low anxiety on the assessment that day. In fact, through the open-response questions, she said that she enjoyed the problem solving involved in the assessment, though she didn't have time to finish all of the problems. In terms of her experiences as a woman, she indicated that she did not doubt that others think less of her math ability. She also indicated that women face unfair evaluations in math courses and that some people feel she has less math ability because of her gender. Her answers to items regarding race-based stereotype threat are more conflicting. She does not doubt that others would think that she has less math ability because of her race and slightly disagrees that her race does not affect people's perception of her math ability, but strongly disagrees that some people feel she has less math ability due to her race, that people of her race often face biased evaluations from others, and that she often feels that others look down on her in math classes due to her race.

Table 24

Survey Responses for Mixed Results Analysis of Student 5H

Scale	Responses in Order of Items
Anxiety	5 – 1 – 0 – 5 – 0 – 1
Gender-Based ST	0 – 0 – 0 – 6 – 0 – 4 – 3 – 0
Race-Based ST	2 – 4 – 3 – 0 – 5 – 0 – 3 – 0
Sexuality-Based ST	0 – 0 – 8 – 0 – 0 – 2 – 8 – 0
Income-Based ST	0 – 8 – 8 – 0 – 8 – 0 – 0 – 0

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 5L (heterosexual, white woman). Table 25 shows the survey responses to all of Student 5L's subscale responses. She did not experience anxiety over the assessment that day. In fact, on the open-response questions she mentioned feeling no stress since the assessment was not for a grade in class. In terms of her experiences as a woman in math courses, she has had some slightly conflicting experiences. She does not doubt that others think you have less math ability due to being a woman, but she also thinks that women rarely face unfair evaluations in math classes. Along with slightly disagreeing that women often face biased evaluations; she also slightly disagrees that her gender identity does not affect people's perceptions of her math ability.

Table 25

Survey Responses for Mixed Results Analysis of Student 5L

Scale	Responses in Order of Items
Anxiety	0 – 0 – 0 – 1 – 0 – 1
Gender-Based ST	0 – 1 – 2 – 5 – 4 – 3 – 3 – 2
Race-Based ST	0 – 5 – 1 – 3 – 6 – 2 – 4 – 0

Sexuality-Based ST	0 – 1 – 7 – 1 – 7 – 1 – 6 – 1
Income-Based ST	2 – 6 – 1 – 2 – 6 – 2 – 4 – 1

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 8A (heterosexual, Native American woman). Table 26 shows the survey responses to all of Student 8A's subscale responses. She had moderate levels of anxiety during this assessment. In the open-response questions, she mentioned observing other women having negative experiences in mathematics. She agreed that some people feel she has less math ability due to her gender and otherwise neither agreed nor disagreed with most of the gender-related items. She answered relatively consistently between race-based and sexuality-based items, and answered in such a way that suggests not having stereotyped experiences. She indicated that she does not doubt that people of her financial status rarely face unfair evaluations in math classes.

Table 26

Survey Responses for Mixed Results Analysis of Student 8A

Scale	Responses in Order of Items
Anxiety	3 – 1 – 2 – 4 – 4 – 5
Gender-Based ST	0 – 1 – 4 – 6 – 4 – 4 – 3 – 4
Race-Based ST	1 – 1 – 7 – 2 – 4 – 4 – 7 – 1
Sexuality-Based ST	1 – 1 – 7 – 1 – 7 – 4 – 7 – 1
Income-Based ST	1 – 1 – 6 – 4 – 3 – 1 – 4 – 2

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Student 8B (straight, Middle Eastern woman). Table 27 shows the survey responses to all of Student 8B's subscale responses. She had little anxiety on the assessment that day. In the open-response questions she claimed not being good at math. She strongly disagreed that Middle Eastern students rarely face unfair bias in evaluation in math classes. She similarly disagreed

with this point about evaluations in regard to her gender. She additionally agreed that some people feel she has less math ability as a woman and strongly disagreed that her gender does not affect people's perception of her math ability.

Table 27

Survey Responses for Mixed Results Analysis of Student 8B

Scale	Responses in Order of Items
Anxiety	0 – 0 – 0 – 4 – 1 – 0
Gender-Based ST	0 – 5 – 8 – 6 – 2 – 0 – 0 – 0
Race-Based ST	0 – 6 – 8 – 0 – 0 – 1 – 8 – 0
Sexuality-Based ST	0 – 2 – 8 – 0 – 8 – 0 – 8 – 0
Income-Based ST	0 – 6 – 8 – 0 – 8 – 0 – 8 – 0

Note: The scale for Anxiety was 0 (strongly disagree) to 6 (strongly agree) while each ST scale was 0 (strongly disagree) to 8 (strongly agree). ST = stereotype threat.

Taken together, in this section, I have put together a joint display of quantitative and qualitative data as well as given a qualitative view of some quantitative data for a smaller portion of students in this study. Given the QuantCrit methodological framework for this dissertation study and the participatory social-justice mixed methods design, the qualitative analysis of the quantitative data in this section contributes a novel-but-needed approach to disentangle the construct of achievement anxiety as it relates to stereotype threat or stereotype threatening experiences. In particular, this section of analysis did not (1) ignore survey items which were thrown out during quantitative analysis or (2) consolidate survey items into a single composite score (after reverse-coding) so that slight distinctions in a student's responses can be noticed and analyzed.

Summary

In Chapter 4, I discussed the results for each of the four research questions. The first two questions showed that gender-, sexuality-, and income-based stereotype threat significantly predicted achievement anxiety on math assessments – while race-based stereotype threat nearly did so ($p = .06$) – with a small effect size and that achievement anxiety was predicted by their recent math assessment score from their class but did not predict the assessment score that day. To answer how students envision their anxiety and stereotype threat effects as they relate to self-report measures of anxiety and stereotype threat, 8 themes were identified. Students answered open-response questions in terms of explanations for performance or emotions, negative emotions, rejection of a connection between identity and performance, identity comparisons, neutral emotions and experiences, their math ability, changes during the assessment, and positive emotions and experiences. I combined the quantitative and qualitative results into a joint display and further outlined experiences of some students by qualitatively describing their quantitative data. In Chapter 5, I will interpret the quantitative, qualitative, and mixed findings from this chapter. In particular, I will draw some conclusions about implications for educational practice and future research.

Chapter 5: Discussion

This chapter presents a summary of the study within this dissertation and conclusions drawn from data presented in the previous chapter. Additionally, I discuss theoretical, methodological, and practical implications and suggestions for future research.

Summary of the Study

This dissertation study aimed to disentangle the relationship between stereotype threat and achievement anxiety for students in first-year mathematics courses. More specifically, I aimed to answer (1) how gender-, race-, sexuality-, and income-based stereotype threats predict anxiety; (2) how anxiety predicts math performance on an assessment; (3) how the students imagine the topics of anxiety and stereotype threat; and (4) how the results of the first three research questions combine to challenge classroom and research norms. I employed a mixed methods participatory social justice design through a Control-Value and Situated Expectancy-Value theoretical lens and QuantCrit methodological lens. In doing so, I aimed to resolve research gaps and inconsistencies in methodological care surrounding studies about the relationship between stereotype threat and anxiety. In particular, this study measured achievement anxiety instead of clinical anxiety (i.e., Spencer et al., 1999), collected data in a real classroom instead of experimental laboratory settings (i.e., Blascovich et al., 2001), and addressed multiple types of social identities for each student in the study (i.e., white women; Johns et al., 1999).

Students completed a short, timed, math assessment before answering questions about their achievement anxiety and stereotyped experiences as well as two open-response questions. One open-response question asked them if there were any other emotional aspects they wanted me to know about and the other asked if they think that others who share their identity would

have had the same experience on the math assessment. Finally, they were asked to report various aspects of their identity and if they were willing to provide their email address for asking them about reflections on the analysis of their answers later.

In this study, I found that gender-, race-, sexuality, and income-based stereotype threats significantly or nearly significantly predicted anxiety. Additionally, anxiety was nearly significantly predicted by performance on students' most recent math assessment in their math course.

Students were selected for qualitative analysis if (1) they had responded to the open-response questions with substantive answers (more than saying "yes" or "no" to the two questions) and (2) if they were considered a particularly significant case. Some students' identities had to be overly aggregated or identified as multiple races, so were determined to be a particularly significant case because there is not a suitable way to fully include their identities without breaking the assumptions of the respective quantitative analyses that were used in determining the other significant cases. Some students were chosen as a particularly significant case because their anxiety was significantly greater than those with other identities. These cases were women, Black students, and gay students.

The qualitative analysis was coded and collected into 9 themes regarding the students' feelings about their identities, their performance, and their stereotyped or emotional experiences. These themes included explanations for their performance or emotions; negative emotions; rejecting the connection between identity and performance; comparing performance and emotions based on identity; neutral emotions and experiences; math ability; changes during the assessment; and positive emotions and experiences.

In the remainder of this chapter, I will substantively interpret the results of each research question from Chapter 4. Additionally, I will discuss the theoretical implications for Control-Value Theory; practical implications for college-level mathematics instructors working with students experiencing anxiety, stereotype threat, or both; and methodological implications for other critical researchers working with quantitative methodologies. Finally, I will discuss limitations encountered throughout this dissertation study and propose future directions for myself and other researchers.

Interpretation of Findings

One of the research gaps being addressed by this dissertation study is the inconsistent results about correlations and predictions between stereotype threat and achievement anxiety, given research settings or construct measures. Therefore, in this section, I will discuss the results as it pertains to the literature. This section is organized by research questions. Other interpretations, limitations, and future directions are further discussed in the later implications section.

Research Question 1: To what extent does gender-, race-, sexuality-, and/or income-based stereotype threat predict achievement anxiety?

The results in Chapter 4 show correlations, which are supported by existing literature. In particular, there is a weak-but-significant positive correlation between achievement anxiety and gender-based stereotype threat, race-based stereotype threat, sexuality-based stereotype threat, and income-based stereotype threat.

In previous studies that included anxiety measures for stereotype threat or identity-based experiences, it was largely gender-based stereotype threat in mathematics or gender-based experiences in STEM that was the focus (Frenzel et al., 2007; Henschel et al., 2023; Johns et al.,

2005; Keller & Dauenheimer, 2003; Leker, 2017; Mangels et al., 2012; Murphy et al., 2007; Osborne, 2001; Schmader & Johns, 2003; Spencer et al., 1999). Some of these studies did not look specifically for correlations between achievement anxiety and gender-based stereotype threat, but of those who did, some studies did not find significant correlations (weak or otherwise) between achievement anxiety and gender-based stereotype threat (Keller & Dauenheimer, 2003; Schmader & Johns, 2003). Like this dissertation study, some others showed a weak-but-significant positive correlation between achievement anxiety and gender-based stereotype threat (Leker, 2017; Spencer et al., 1999). Like this dissertation study, Leker (2017) chose to measure stereotype threat through a survey instead of manipulating it within their study design. Therefore, the study from Leker (2017) might be most comparable to this result in this dissertation. Unlike this dissertation, however, Leker (2017) measured many students in relation to their success in all of STEM and did not include an assessment which might further measure performance effects of such stereotype threat. Additionally, their measure for stereotype threat was created through the qualitative portion of their study and had not been previously validated. The fact that this study showed that gender-based stereotype threat positively predicts achievement anxiety indicates the possibility that careful consideration for the achievement anxiety measure (along with other careful methodological considerations) corroborates and furthers the results of Leker (2017) and Spencer and colleagues (1999). While the results in this dissertation showed the hypothesized relationship between gender-based stereotype threat's relationship and achievement anxiety, the results were less consistent for race- and sexuality-based stereotype threat.

Race-based stereotype threat and sexuality-based stereotype threat had also been addressed in literature alongside anxiety. For race-based stereotype threat, some studies that

included a correlational analysis with anxiety did not find a relationship between the two (Aronson et al., 1999; Schmader & Johns, 2003; Steele & Aronson, 1995), while one study like this did find a correlation (Blascovich et al., 2001). The study from Blascovich and colleagues (2001) had to be conducted in an experimental setting as their measure for anxiety was from measuring blood pressure, while this dissertation study was conducted in a classroom and collected self-report survey data for achievement anxiety. For sexuality-based stereotype threat, the only study, to my knowledge, which addresses a correlation with anxiety found a positive correlation (Raymond, 2014). Raymond (2014) collected data via paper survey through the mail. In the current dissertation study, race-based stereotype threat and, separately, sexuality-based stereotype threat both positively predict achievement anxiety. For both race-based and sexuality-based stereotype threat, studies are less frequent in the domain of mathematics pertaining to anxiety as compared to studies in gender-based stereotype threat in the domain of mathematics. Therefore, previous studies (and the present study) should be considered with an eye toward methodological care as well as situative considerations (such as the way that participants must provide their data). I leave the discussion of these aspects for the later implications and limitations sections.

One interesting result is with the relationship between income-based stereotype threat and achievement anxiety. Like race and sexuality, it is infrequently studied in terms of stereotype threat in the domain of mathematics. So infrequently studied that I am not currently aware of research that relates income-based stereotype threat to achievement anxiety in mathematics. The hypothesis for a positive and significant prediction was based on generalizing other types of stereotype threat out to this less-studied type of stereotype threat. The income-based stereotype

threat in this study appears to be more akin to gender-based stereotype threat: a positive predictor of achievement anxiety.

A possible explanation for this result is that level of income might be quite salient for participants at any given time – and one of the requirements of stereotype threat is that the threatened identity is salient (Spencer et al., 1999). In fact, this interpretation is supported by a study – one that did not identify stereotype threat as the phenomenon of interest – indicating that making financial concerns more salient impaired the cognitive abilities of college students in the study, particularly when they are reminded that the tasks they are completing are connected to their future success and potential financial stability (Destin & Svoboda, 2018). While I do not think that there were success- or future-related statements in the instructions for participation in this study, the data was collected near the end of a semester, with final exams looming and enrollment windows open. In that case, any student facing financial concerns might be worried about their success during this semester as well as how to pay for either the current or next semester's tuition. Additionally, income-based stereotype threat predicting achievement anxiety in this study may be one explanation behind the phenomenon of levels of income inequality predicting test anxiety in many countries (King et al., 2024).

Theoretically, CVT suggests that anxiety occurs when a student is focused on the outcome but doesn't know what it is yet (prospective), feels like they have medium control over the outcome, and they suspect that they failed (Pekrun, 2006). Therefore, since different types of stereotype threat predicted levels of achievement anxiety in this dissertation study (albeit weakly) it may be that students experiencing the most stereotype threat additionally did not perceive a high level of control for the outcome of their assessment score and suspected that they

did not do well. Having (at most) a medium sense of control is reasonable since they were not prepared ahead of time for the content of the assessment in this study.

Methodologically, QuantCrit asks us to consider that *numbers are not neutral* and that *data cannot speak for itself* (Gillborn et al., 2018). With these tenets in mind, I interpret the findings according to previous studies and, later, find implications, limitations, and future directions for research from additional angles besides my own subjective stance in the study. It is my responsibility as the researcher on this study to speak on behalf of the data, and to interpret it in a way that most effectively honors the students in the study.

Taken together, the goal of this research question was to begin disentangling the relationship between stereotype threat and achievement anxiety by looking at appropriate self-report measures of the latter and observing whether there are the expected positive predictive relationships from each type of stereotype threat to achievement anxiety. The results of this research question add to the patterns found in some gender-based stereotype threat studies relating to achievement anxiety, but additionally add to the research in race-, sexuality-, and especially income-based stereotype threats and their respective relationships to achievement anxiety.

Research Question 2: To what extent does achievement anxiety predict stereotype threat performance effects (i.e., math performance)?

This study operationalized stereotype threat performance effects as the performance that a student would have on their math assessment that day as a score out of 10. Since there was a practically significant positive correlation between each type of stereotype threat and achievement anxiety, and because stereotype threat is known to affect performance based on identity – including gender (e.g., Spencer et al., 1999), race (e.g., Steele & Aronson, 1995),

sexuality (e.g., Raymond, 2014), and income (e.g., Tine & Gotlieb, 2013) – achievement anxiety should negatively predict the score on the math assessment the students took that day. Instead, their most recent math assessment score taken in their math course negatively predicted achievement anxiety on the day that data was collected.

It is typical for a correlation between math anxiety and math competence to be more moderately negative (Barroso & Ganley, 2021; Hembree, 1990), but perhaps the correlation detected in the current study was weaker and less significant due to surrounding factors. For example, the assessment administered did not count towards their grade and students would not have known the content of the assessment ahead of time. As a result, they (a) likely could not have prepared for it and (b) might not have felt as anxious as usual. In fact, some stated as much in their open-response answers.

Theoretically, CVT does not address what happens after someone experiences an emotion. Rather, it has appraisal-related inputs, and the output of the theory is an emotion (Pekrun, 2006). The situated aspect of SEVT, however, acknowledges that engagement with a task, in addition to interpretations of experiences and perceptions of abilities, activities, and outcomes, tend to feed back into the situation such that this data can be re-evaluated at each moment to decide when and how to engage with the next task (Eccles & Wigfield, 2020). It is perhaps within this re-evaluation of previous experiences with math assessments that gave some students the internal permission to engage less with the assessment included in this study, and a possible explanation for why there is a stronger relationship between achievement anxiety and a real, recent assessment in their class (one that has outside-of-the-study consequences for answering many questions incorrectly) than there is to this “not real” assessment in the study

(that does not have consequences tied to their coursework and their anonymous performance is only known by me).

Methodologically, QuantCrit suggests that quantitative research should be done with an eye toward *social justice* (Castillo & Gilborn, 2022). Rather, this study should enact meaningful change in research and classroom settings. With this tenet in mind, I again discuss the difference between assessing (a) a predictive relationship from achievement anxiety to the assessment taken during the study and, separately, (b) assessing a predictive relationship from a real-life assessment that the students took in class recently to the achievement anxiety data collected during the study. At the end of a semester when the data was being collected, a student may not care about any assessment that does not have a tangible reward – such as a grade. Some students may have tried their hardest anyway, due to social desirability or math identity factors, but a change that should be considered for stereotype threat research is to complete studies like this with real assessments for their classrooms. If the assessment in this study had been a real quiz for their math course, the results for this research question (and potentially for the first research question as well) would likely be more ecologically valid.

The purpose of this question was to further disentangle the relationship between anxiety and stereotype threat by focusing on achievement anxiety's relationship with the effect of stereotype threat related to performance. Based on the results of the current research, this relationship does exist, though not to the significance level or strength expected based on the literature. The results of this research question thus lightly support the patterns found in the literature between achievement anxiety and math performance.

Research Question 3: How do students with less-represented social identities within the study's sample or groups with non-normative relationships between their levels of anxiety and stereotype threat (as evidenced through quantitative analysis) envision their experiences in the math task?

When students were given the opportunity to provide more information about their emotions, some opted to include information about why they experienced their emotions or why they performed the way they did. It is not entirely unexpected that students would take an opportunity to pre-excuse their emotions or performance if they are under the effects of stereotype threat, as that topic has been researched previously (i.e., Steele & Aronson, 1995). Alongside this theme, 18 students made comparisons to others within their own identity groups, including those who share their anxious tendencies, available resources, previous math experiences, or their social identity. Comments about social identity included discussions about being stereotyped or within-culture expectations of success.

Students who were under stereotype threat may have had a mismatch between (a) what they thought they were supposed to do or who they were supposed to be with (b) how they were performing in the domain of mathematics. In particular, students who are stereotyped for being bad at mathematics based on their social identity might feel additional pressure to succeed to fight against that stereotype while students who have within-culture expectations of success – and who are stereotyped for being good at mathematics – might feel additional pressure to succeed to fulfill that stereotype. These situated aspects of stereotyped experiences are in alignment with previous studies on stereotype threat (e.g., Tine & Gotlieb, 2013, who found that having stereotyped experiences on multiple parts of a student's identity increased stereotype threat effects, particularly if the student was a racially-minoritized woman from a lower-income

background) as well as the "model-minority" stereotype (Nabb, 2022) and consequences of Asian and Asian American students being positively stereotyped. In particular, there is an experience of increased depressive symptoms for Asian and Asian American students who believe that they do not experience racism in the United States (Suh et al., 2023).

While the study from Suh and colleagues (2023) is intended to be about Asian and Asian American students, the results suggested that higher beliefs about *unrestricted mobility* – the lack of experiencing racism in the United States – impeded the functioning of self-efficacy and led to those increased depressive symptoms. In the qualitative portion of this dissertation study, there were 18 students who felt – some seemingly quite strongly – that identity has nothing (or very little) to do with ability or performance. If the results from Suh and colleagues (2023) are transferable to the identities typically considered dominant within the mathematics domain that we have within our collection of social identities, then it is possible that these students – as men, Asian students, white students, or heterosexual students – have higher beliefs about their unrestricted mobility and might end up with increased depressive symptoms as a result. In fact, 17 of these students fell into at least one of these dominant identity categories – including two men, one (only) Asian student, 10 (only) white students, and 13 heterosexual students – while one student chose not to disclose any of the aspects of their identity. Some of these 18 students provided alternative causes for differing performance such as grading biases, resources, studying, and anxiety. Taken together, these 18 students who find that their emotional experiences are not about their identity may believe in unrestricted mobility within their dominant identit(ies) and may be at higher risk for self-effiacy impediments or increased symptoms of depression.

In terms of emotions, there were 20 students who brought up negative emotions in their open-response answers, typically in relation to the assessment that day, their usual emotions

during assessments, the way they cope with negative emotions, or in relation to negative emotions being a normal mathematical experience for everyone. Each of the 20 students who had negative emotions or experiences had at least one identity in a non-dominant category in the domain of mathematics – including 17 women, 1 transman, 6 Black/African American students, 2 Latine/Hispanic students, 1 Native American student, 1 bisexual student, and 1 gay student. It is worth noting that 9 of these students had more than one identity in a non-dominant category in the domain of mathematics. There were 14 students who had a neutral emotional experience on the math assessment because they perceived it as being low stakes or easy or they felt that it was a typical experience. Of these 14 students, 6 of these students had more than one identity in a non-dominant category in the domain of mathematics, while the rest were women (white or Asian) and 2 of these students identified as Asian-Filipino or Asian/white males. Only 2 students experienced positive emotions, including the love for math and enjoyment for problem solving (one of which was in multiple dominant identity categories and the other was in multiple non-dominant identity categories). The theoretical lenses of CVT and SEVT offer some explanations here as they both involve expectations for success in relation to motivation and emotion (Eccles & Wigfield, 2020; Pekrun, 2006). Recall that within CVT, the emotion that a student experiences might depend upon the object focus (activity, outcome/prospective, or outcome/retrospective) in addition to the amount and locus of control and value the student imagines having (Pekrun, 2006). At the time that students were filling out these surveys, they had just experienced an activity object focus during the assessment – which according to CVT, includes experiencing emotions like enjoyment, anger, frustration, or boredom (Pekrun, 2006) – and would now have an outcome/prospective object focus – experiencing emotions like anticipatory joy, hope, hopelessness, anticipatory relief, or anxiety (Pekrun, 2006). A combination of these emotions are

likely most salient at the time that students are filling out the surveys from this study – though they also might call back to their emotions on previous assessments as well.

CVT may also explain some of the six students who reported experiencing some kind of change during the assessment, including improved emotions, increased physical symptoms, a learning experience, or giving up on the test. That is, emotions changing based on the object focus, control, and value is part of the composition of CVT (Pekrun, 2006). Additionally, portions of SEVT – such as environmental or value appraisals – could explain why a student would give up on the assessment before time is complete. Specifically, within the situated aspect of SEVT, a student's environment (along with cultural milieu and previous experiences) might influence whether they engage in an activity. In addition, their subjective value appraisal of the task – intrinsic (expected gains from the task), utility (expected future benefits from the task), attainment (identity attachment to the task), and costs of completing the task (effort, opportunity, emotional, and cultural; Archer et al., 2022; Eccles & Wigfield, 2020) – also feeds into this determination. Only one student cited giving up on the assessment, saying that she "would not be able to solve most of the equations correctly." She did not say why this meant that she gave up, nor did she indicate that she literally stopped working on the assessment, but the possibilities for giving up the effort toward the assessment might include an unfavorable environment for solving the math problems (like sitting next to someone she did not feel comfortable near or not being prepared to take an assessment that day); not expecting to gain anything from the result of the assessment (personally or professionally); and not identifying with the domain of mathematics enough to feel any level of attainment value. Additionally, she could have found this assessment to be too costly – expending effort or being emotionally taxing.

There were 13 students who discussed their mathematical abilities, specifically when it was a part of their identity to be good or to not be good at math. From early research in stereotype threat, students who have an aspect of their identity stereotyped in mathematics and who feel that it is a part of their identity to be good at mathematics will be particularly at risk of experiencing stereotype threat (Spencer et al., 1999; Steele & Aronson, 1995). The students who discussed their mathematical abilities as favorable may, again, experience either stereotype boost (Shih et al., 2002) or a pressure to succeed from the "model minority stereotype" (Nabb, 2022). Those who discussed their mathematical abilities as unfavorable might, instead, be experiencing stereotype threat in their work or emotional/motivational aspects of CVT and SEVT. In particular, Student 5D (who said, "No I have never enjoyed math or been good at it so I think someone who is better at math would have a different experience.") might have (at least) a low attainment value for mathematics before providing their responses for this dissertation study.

The goal of this research question was to give students a chance to express their emotions and experiences within their identity on math assessments. The results of this research question align with previous research and with the theories of CVT and SEVT.

Research Question 4: How do the quantitative results on the relationship between anxiety and stereotype threat and the qualitative results on perceived relationships between anxiety and stereotype threat for less-represented groups combine to corroborate, extend, or challenge previous research and the typical classroom culture?

In mixing the data via joint display, most of the quantitative results were corroborated by qualitative data from the students in this study. Due to the nature of the qualitative analysis and the sample size, there was no qualitative evidence to support the quantitative result that sexuality-based stereotype threat predicts anxiety. Instead, the student who identified as gay and

who was included in the qualitative analysis only provided evidence of anxiety due to not feeling prepared about the assessment ahead of time, which was not a component of their identity, but a situational factor for their class.

In mixing the analysis of quantitative and qualitative data, I sent profile summaries to each student who had provided an email address for the purpose of member checking. Their profile summary included a summary of all survey items and open-ended responses and short statements of analysis about their responses. In the following subsections, I discuss these profiles, categorized into gender-, race-, sexuality-, and income-based experiences. In each, I identify opportunities to challenge previous research and the typical classroom culture.

Gender-based experiences. Some students who identified as women seemed to be well aware that stereotypes about women exist, but did not have personal experiences with these stereotypes, firsthand. Student 1L (straight, Black woman) may have shown this tendency by including slightly inconsistent answers on similarly worded survey items regarding gender. Student 2L (straight, Native American woman) might have indicated this awareness by acknowledging both that women are often evaluated unfairly in math classes and indicating that she doesn't think she has been looked down upon or thought to be less able in mathematics due to being a woman.

Like Students 1L and 2L, Student 4K (bisexual, white woman) might acknowledge that stereotypes exist about her gender, but she has not had specific experiences with unfair evaluations or judgements due to those stereotypes. Student 4K additionally thinks that if someone is worried about unfair evaluation that they should not disclose those stereotyped aspects of their identity.

The tendency for these students to acknowledge the existence of stereotypes alongside indications that they have not experienced being personally stereotyped may be from their perceptions of the possibility and probability that they will be stereotyped in a certain space (Wout et al., 2009). That is, a student who feels less likely to be stereotyped – by having an in-group instructor, for example – has some stereotype safety (Wout et al., 2009). I will note that these three students were in classes with men instructors, and that men were the instructors of just over half the sections of classes included in this study. On the other hand, I collected the data from each of these classrooms, and have the same gender identity with these students. Although I did not share my gender identity out loud during data collection, my features and dress tend toward a feminine style. My gender presentation may have affected the responses for these students.

All three of these students – 1L, 2L, and 4K – answered all 10 of the math assessment questions and only got one answer correct. They additionally all got between 60% and 70% on their most recent math assessment in the same course. Only 1L responded with low levels of anxiety, while 4K was more moderate, and 2L was quite high. These variations between anxiety levels alongside consistencies in assessment scores and feeling stereotyped might indicate an intersectional anxiety experience, perhaps dependent upon different aspects of identity (like overlapping experiences of stereotype threat) as well as situational aspects regarding feelings about assessments, in general, or feelings about this assessment. For example, each of these students identifies as a woman and has one additional aspect of their identity that differs from the dominant identity in the math domain – a Black woman, a Native American woman, and a bisexual woman. In addition to feeling some level of gender-based stereotype threat, they could also feel some level of race-based or sexuality-based stereotype threat. These experiences could

produce effects of both types of stereotype threat at the same time in addition to effects that can only occur from the two types of stereotype threat mixing – a *multiplicative effect,* as is typically the case in intersectionality (Crenshaw, 1989). Additionally, the results suggest that gender-based stereotype threat predicts the level of achievement anxiety but did not include survey questions about testing anxiety or math anxiety, in general. I suggest that further research be conducted regarding the intersection of identities in relation to achievement anxiety and stereotype threat along with intersections of various types of anxiety in achievement situations.

In contrast, other students who identified as women seem to have indicated having explicit experiences with bias or feeling stereotyped as women in mathematics settings. Student 1H (white, bisexual woman) indicated this through the item about unfair evaluation in mathematics. In addition to this selection, Students 5H (straight/bicurious, Black, white, and Vietnamese woman) and 8B (straight, Middle Eastern woman) indicated that they do not doubt others think less of their math ability because they are women. Although she mostly responded neutrally, Student 8A (heterosexual, Native American woman) agreed with Student 5H that some people feel she has less math ability due to her gender. Student 5L (heterosexual, white woman) similarly does not doubt that others think less of her math ability as a woman, but also thinks that women rarely face unfair evaluation in mathematics – perhaps indicating that she did not expect there to be widespread issues against women in math environments, but that she might have had some experiences being stereotyped in her personal life. These experiences were either not frequent or not blatant since none of her survey answers here were at the stronger ends of the scale.

Students 1H, 5H, 5L, 8A, and 8B all have quite variable performance on the math assessment – ranging from 1 to 6 correct answers and 0 to 6 blank answers. Their anxiety levels

vary from low to moderate. While some items may be answered at a high level of anxiety, their overall anxiety levels are all less than 3.5 out of 6. This could, again, have to do with intersectional experiences.

Student 1E (gay, white and Black transman) might have indicated that there are portions of his life that were lived with a more feminine expression and had some gender-based stereotype threat. He suspected that his gender identity might affect people's perception of his math ability.

Gender-based experiences appear to have some overlap with other identity-based or situational experiences – considering that anxiety for these particular students are not fluctuating with gender-based stereotype threat according to the overall quantitative results. In a challenge to research norms, it would be appropriate for future studies which serve to further disentangle the relationship between stereotype threat and achievement anxiety to be done through an intersectional lens. It may be due to a lack of consideration for intersectionality that quantitative results continue to be muddied or weak. In challenging classroom norms, instructors might follow advice from Good and colleagues (2008) such that norms in the classrooms or on assessments involve statements about the acknowledgement of stereotype threat as well as statements that their class or tests do not result in different scores between gender identities – i.e., a stereotype nullification manipulation outside of an experimental study. I also warn instructors here that local laws affecting education – and the interpretation of these laws by local communities and politicians – may prove to be a barrier to this kind of classroom intervention. If it appears that your teaching position would be unsafe by using this intervention, then an immediate alternative would be to fight against such legislation through your vote for local, state, and federal lawmakers.

Race-based experiences. Like gender-based experiences, some students in this dissertation study knew that stereotypes based on their race exist, but do not necessarily think that they have been stereotyped. Student 2L (straight, Native American woman) indicates this by slightly disagreeing that Native American students face unfair evaluations. Students 1E (gay, white and Black transman) and 8A (heterosexual, Native American woman) similarly answered many race-related questions relatively neutrally. Student 5H (straight/bicurious, Black, white, and Vietnamese woman) answers questions in a more conflicting way so that perhaps her multiple racial identities have meant that she is sometimes positively stereotyped and sometimes negatively stereotyped in terms of mathematical ability. Conflicting answers about racial stereotyped experiences could also indicate that she does not have any experiences being stereotyped in math based on her racial identity, like Students 2L and 1E.

Unlike gender-based experiences, these students – 1E, 2L, 5H, and 8A – have moderate-to-high levels of anxiety and a variety of math assessment scores. Racial identity could be offering a different level of intersectionality that other social identities do not offer, in that students may identify with multiple racial identities at once (*intra-racial intersectionality*; Albuja et al., 2020). As a reminder, I am using the term race here to include aspects of ethnicity and culture as well. To be Native American or to be Vietnamese is not to be in a racial group – but includes aspects of ethnicity or citizenship and can include culture if these students are raised or live within communities which include many others in these groups. All four of these students, then, may have conflicting messages about their race and their ability to succeed in mathematics, or in higher education more broadly. In fact, Albuja and colleagues (2020) found that participants who were bi-racial (including combinations of being Black, Latine, Asian, and Native American) received conflicting information about their racial identity such that others

would question their identity or reject one of their racial identities. These participants with a lot of conflict with others about their identity perceived having a lower public regard than those who did not have these experiences (Albuja et al., 2020).

Like the students in the previous paragraphs, Student 1D (heterosexual, Black woman) seemed to acknowledge that stereotypes about her race exist, but she was not sure if others are thinking that about her, specifically. Alternatively, she might not have felt strongly (or felt tipped in a particular direction) because of some phrase in the survey items. She might have hoped that her race does not affect people's perceptions (resulting in a response close to neutral); had the word "often" been removed from a statement that says that "people of your race are often facing biased evaluations", perhaps she would have answered less neutrally. Other answers seemed to indicate that she has experienced some negative stereotyping, but she may have also been aware of students who have had it worse. Further discussion about the wording of these items will be discussed in the limitations section later.

Some other students may have had explicit stereotyped experiences based on their race. Student 1L (straight, Black woman) felt that people in her shared racial identity are outright unfairly evaluated (perhaps both by instructors grading unfairly and classmates passing on unfair judgments). Student 3B (straight, African American woman) answered most race-related questions in a neutral way, but she also said that because of her race "people don't automatically assume" that she is smart – which isn't the same as saying that they automatically assume that she is not smart, merely that their first assumption about her is not that she is. Both students 1L and 3B responded with low levels of anxiety in the math assessment that day, felt neutrally that they are good at math, and strongly agreed that it is important that they be good at math. Both of these Black or African American women were citing an unfair evaluation based on their racial

identity, which might indicate that they must interact with peers and instructors who believe stereotypes which match the societal stereotypes that exist about Black or African American students in academic settings (Steele & Aronson, 1995).

A few students experienced bias in evaluation based on their race that is positively or not widely stereotyped in mathematics. Students 3G (heterosexual, Asian/white male) and 8B (straight, Middle Eastern woman) expressed that there may be some bias in evaluation for people of their respective races and that their race does not affect the way people think about their math ability. Student 3G also said that "there are high expectations on school grades for people in my culture," and those high expectations might lead people to be biased in evaluation of people in his race because they expect perfection. This could mean either that he has faced a lot of pressure to succeed or even that the expectations for his success mean that he has been graded more harshly than others. Both of these students – 3G and 8B – responded with very low levels of anxiety, and student 8B felt that she is not good at math, but did not have any other responses about emotion or identity.

Like gender-based experiences, race-based experiences may intersect with other identity-based or situational experiences, but as stated previously race-based experiences have an added intersection that is more internal to the concept of race – such as identifying as two or more racial identities. Since race is often conflated with ethnicity and culture (DeCuir-Gunby & Schutz, 2014), and since a person can identify as multiple races, race-based experiences may be conflicting for some students, particularly those who have one aspect of their racial-identity being positively stereotyped in mathematics or academics and another part of their racial-identity being negatively stereotyped in mathematics or academics. As a challenge to research norms, I suggest that studies be conducted with more care toward multi-racial experiences (e.g., Albuja et

al., 2020). As a challenge to classroom norms, I suggest the same as I did for gender-based experiences – that whenever possible, a stereotype nullification intervention should occur.

Sexuality-based experiences. Student 1E (gay, white and Black transman) might have indicated that there are portions of his life which were lived with a more feminine expression and had some gender-based stereotype threat. Alternatively, these responses may be intersecting with his experience with his sexuality. He indicates that others may think he has less math ability as a gay man, and experienced moderate levels of anxiety that day. I again challenge researchers and instructors to take an intersectional lens and a stereotype nullification intervention to combat these concerns. In particular, an intersectional lens in research will help in the interpretation of experiences like Student 1E who has a sexuality-based stereotyped experience as a gay man, but previously had a gender-based stereotyped experience as a transman who once had a more feminine expression. These are both in addition to his experiences as a multi-racial student. An intersectional lens does not assume that Student 1E is merely the sum of the individual experiences he may have as a gay student, a white student, a Black student, or a transman. Rather, it considers each of these experiences in addition to intersections of these experiences.

Income-based experiences. Student 3G (heterosexual, Asian/white male) was aware that bias toward people based on finances exist but believed that performance itself comes down to available resources as a student goes through schooling. Student 3H (straight, Native American woman) might have known that a stereotype about people in her specific financial status existed but that she had not personally experienced the effects of this stereotype. Alternatively, she could not have been sure that there are stereotypes about people with her financial status. She experienced moderate levels of anxiety. There was not a student in the qualitative component of the study who was chosen based on their financial status, but income-based stereotype threat

explained more of the variance in anxiety than race-based or sexuality-based stereotype threat did. Based on the combination of qualitative analysis of quantitative findings (i.e., that the students who had their quantitative findings qualitatively analyzed either did not disclose their financial information or did not feel affected by their income-level) as well as the overall quantitative results (i.e., that income-based stereotype threat was more akin to gender-based stereotype threat than race- or sexuality-based stereotype threats), I challenge research norms by considering income-based experiences as part of the mathematics learning experience, and include it regularly in discussions and research of stereotype threat. To challenge classroom norms, I do not necessarily suspect that a threat nullification intervention is necessary, because the students who mentioned financial status seemed to link their concerns to resources more than stereotypes, themselves. Resources of K12 schools and of students may be mediating or moderating factors of stereotype threat on anxiety and performance. For example, increased funding to certain initiatives within K12 schools has shown increased student achievement (Greenwald et al., 1996) and the students in this study suggest that performance is not necessarily related to personal finances or stereotypes about finances, per se, but the resources they may have at their disposal. I would suggest, then, that those responsible for higher education work to ensure ample resources are available to all students, particularly those who did not have resources in their K12 environment. I further encourage local legislatures to disproportionately fund the schools in lower-income areas to ensure equitable outcomes for students in these areas.

The purpose of this research question was to mix the data and analysis of quantitative and qualitative components of the current study to challenge research and classroom norms. For research, I suggest that future researchers in these topics focus on intersectional experiences – including the intersections of gender, race, sexuality, income, and situations as well as the

intersections within race. For classrooms, I suggest that people vote to ensure that educators can implement appropriate intervention without fear of retaliation. In a safe classroom environment, I suggest instructors implement threat nullification interventions. I also suggest that those with the power to control financial resources for classrooms and math programs focus on getting additional resources to areas or students who have not had those resources in the past.

Implications and Recommendations

The challenges to research and classroom norms in the answer to the mixed-analysis research question serve as a starting point for implications in research and teaching practice. Based on individual components of this study, however, additional implications and recommendations are listed below.

Practical Implications and Recommendations

While we continue to work towards disentangling the relationship between achievement anxiety and gender-, race-, sexuality-, and income-based stereotype threats, the concerns from some students about feeling stereotyped or facing biased evaluations suggest that we should continue working in classrooms to help prevent stereotype threat, and potentially prevent high levels of negative emotions like anxiety. One potential solution is with the types of help that we offer a student when they are struggling, but we should take care to offer the right kind of help in this situation. A study from Lee and colleagues (2023) focuses on types of help for people at work. They showed that women perceived having lower levels of competence and higher levels of believing stereotypes following the receipt of nonempowering help. Men did not have these results, and women who received empowering help similarly did not have these results. In transferring this recommendation to the classroom, *empowering help* in class and while studying could include letting students "get their hands dirty" while *nonempowering help* might look like

lecturing, doing problems for the students, using math apps or other modes of artificial intelligence.

While offering empowering help might prevent lower levels of competence and higher levels of believing stereotypes, I want to warn classroom instructors against trying to control students or their emotions. Recall that according to CVT, achievement emotions partially depend upon how much control the student feels over the activity and whether control belongs to them or their instructor (Pekrun, 2006), and the students who feel that someone else had the control over a positive outcome may experience gratitude but would experience it instead of the pride they'd experience if they felt like they were in control. Furthermore, people who believe that their own emotions are controllable tend to see positive achievement-related results (A. M. Smith et al., 2023), but people who think others can (and should) be controlling their emotions do not inspire positive results (A. M. Smith et al., 2023). In fact, when someone expects another person to control their emotions, the person on the receiving end may experience increased pressure and blame from that external person (A. M. Smith et al., 2023). Additionally, forcing someone to reappraise the emotion of anxiety (or similar emotions that appear alongside stereotype threat) sometimes leads to worse feelings, and if reappraisal works, it is sometimes not functional – in the sense that relieving too much stress might mean worse performance (Ford & Troy, 2019).

Taken together, instructors should approach their mathematics teaching with care: they should not expect students to be able to choose enjoyment over anxiety, but the current study's findings, coupled with the broader literature, suggest working to empower students so that they may experience more enjoyment than anxiety.

Theoretical Implications and Recommendations

There were several students who brought up situational aspects in relation to their emotions, including experience in their identity. These situational aspects include resources, feeling ill-prepared for the math assessment, community expectations for math success, and the fact that the assessment was not for a grade. These results reinforce that the theoretical lens of CVT (Pekrun, 2006) for viewing emotions as they relate to stereotype threat would not have been enough for this study. While I could see the need for a situative aspect within my theoretical lens – offered through SEVT (Eccles & Wigfield, 2020) – at the beginning of designing this study, these results suggest revisiting CVT to include situative components. In particular, I recommend that researchers continuing to work with CVT borrow from SEVT the acknowledgement that students "are uniquely positioned due to their own unique histories, memories, endowments and their quite specific location in time and space to deal with their set of behavioral options at any one point in time" (Eccles & Wigfield, 2020, p. 10). I acknowledge that this might mean creating a more complicated theoretical framework, but as it stands, CVT does not have the ability to view achievement emotions in a useful and applicable way. For example, a situative aspect to CVT might involve the reasons that a student perceives the amount of control they have or the value they hold for success on the given activity, based on their previous experiences with their instructor, all previous instructors, their classmates, their cultural or familial upbringing, the environment of their school, among others.

Another example of a situative aspect for stereotypes as they relate to emotion comes from Stanaland and colleagues (2023), who created a model for fulfilling stereotypical gender roles. According to this model, if men expect to fulfill certain masculine stereotypes for whatever reason, and then don't fulfill those stereotypes, they might have an external (perhaps aggressive)

response or internal (perhaps anxious) response. They suggest that their model really only applies to those who strive to conform to "rigid masculinity norms" but could potentially affect men who are gay or trans. Additionally, they suspect that their framework would also apply to other identity groups alongside that identity group's norms (e.g., women and femininity norms; Stanaland et al., 2023). Considering that mathematics is considered masculine within society, women experiencing stereotype threat might have internal anxious responses due to not fulfilling a masculine stereotype. Further study would be needed to determine if this model is applicable to gender-based stereotype threat for women in mathematics. This model would address a situative aspect alongside CVT in that it provides one possible explanation for why a student (a) has value for successfully completing a task (i.e., to maintain status within masculinity norms) and (b) perceives having a certain level of control over the outcome or performance on the task (i.e., to feel confident within masculine stereotypes to successfully complete math tasks; Pekrun, 2006). I bring up the model from Stanaland and colleagues (2023) here to serve as an example of other situative concerns leading to achievement emotions besides the object focus and timing offered by CVT.

Methodological Implications and Recommendations

One purpose behind this study was to take great methodological care in the process of disentangling achievement anxiety and stereotype threat experiences. In particular, previous studies had measures for anxiety that were better matched to the construct of clinical anxiety (Aronson et al., 1999; Schmader & Johns, 2003; Spencer et al., 1999). This study has shown an appropriate measurement for achievement anxiety, which may be reliable in other math classroom studies. Beyond reliability, it was also practical in a methodological sense given that it was only a few items long. Given the established reliability through the pilot study and in this

dissertation study, I suggest that future researchers consider the instrument used in this study to answer other research questions about achievement anxiety. This instrument is particularly attractive for use in stereotype threat studies because its measured construct is achievement anxiety, as opposed to clinical anxiety.

I also encourage other researchers conducting future stereotype threat work to consider some of the methodological choices made in this dissertation study using the QuantCrit lens (Gillborn et al., 2018). In particular, I suggest that other researchers regularly employ open-response questions for social identities to continue stereotype threat's acknowledgement that *groups are neither natural nor given* (Castillo & Gilborn, 2022). Doing so gives participants the opportunity to identify in their own terms, and the researcher the option to aggregate in a way that makes sense according to their research questions while still honoring the nuanced nature of participants' identities. For example, in this dissertation study, almost every student who identified as Asian specified their community's country of origin; however, they would not have had the opportunity to do so had response options been closed. These students might have known that Asian or Asian American students in math are often seen as a monolith, and wanted to clarify that they are (for example) Vietnamese or Indian.

Limitations

Although this study offers plenty of strengths through its methodological lens and recommendations for research and practice, there are limitations to consider. In this section, I discuss the limitations, and suggest future directions for research based on these limitations.

One concern is with the stereotype-threat instrument used. In particular, the instrument had been created for use with gender-based stereotype threat (Spencer, 1993), and I modified it to also include subscales for race-, sexuality-, and income-based stereotype threat. Each subscale

(after inverting scores for reverse-worded questions) was not reliable without significant modifications by cutting questions from the composite score. Upon reflection, there are a few reasons why some items were not as consistent as I would have hoped. For example, there is a pair of items that appear to be reverse-coded versions of each other such that we'd expect (after inverting the score of one of them) to respond the same way. One item says (using income-based stereotype threat as an example) "People of my financial status rarely face unfair evaluations in math classes", while the other says "In math classes people of my financial status often face biased evaluations from others". If the only difference were the words "rarely" and "often", these questions might succeed at confirming the same idea. The issue, however, is that one might be implying that they are being unfairly scored by their instructors and the other might be implying that they are facing bias in more social situations in the classroom – which might occur with peers or instructors. It is perhaps because of this difference in potential interpretations that Item 5 ("People of my financial status rarely face unfair evaluations in math classes.") had to be removed from each subscale to achieve reliability.

Item 2 was also removed from each subscale, but for a different reason. Item 2 stated "The test may have been easier for people of similar finances", which is more of a measure of stereotype belief, than feeling stereotyped. If a student does not believe that stereotypes based on gender, race, sexuality, or financial status are true, then they might answer on the low end of the scale (strongly disagree) regardless of what those stereotypes say.

For gender-based stereotype threat, Items 1 and 3 were also removed, perhaps because gender-based stereotypes are the most infamous in mathematics as compared to stereotypes about race, sexuality, or financial status. Item 1 stated "The experimenters expected me to do poorly on the test because of my gender", and Item 3 stated "I doubt that others would think that

I have less math ability because of my gender." Both items indicate a belief that another person is judging them based on a stereotype – either generic others or the researcher. Perhaps students with beliefs about unrestricted mobility (Suh et al., 2023) as women in academia alongside women who do expect to be stereotyped create this inconsistency.

Further research should be conducted to find appropriate measures for stereotype threat – either validating based on the remaining items in this study, or an entirely new instrument – such that it can be used in studies like this. One such instrument exists for the purpose of categorizing students into different levels of stereotype threat but would not be useful for use as a continuous variable (Social Identities and Attitudes Scale; L. Smith & Cokley, 2016). In working toward validation of the current study's instrument, I might first include some more explicit items about being stereotyped such as "There are stereotypes about my social identity's success in mathematics," "I think about stereotypes about my social identity while studying," "I think about stereotypes about my social identity while taking assessments," and "I feel affected by stereotypes in my academic performance in mathematics" – all on the same strongly agree to strongly disagree Likert-type scales (inspired by the behavioral response items in Garibay et al., 2020).

Moving beyond the instrumentation, the settings within each classroom could also influence the data collected and conclusions drawn from it. Data was collected during a spring semester, which meant that a couple of days I attended the classes for data collection were stormy and others were beautifully sunny outside, both resulting in low attendance. A couple of other days were at the end of the week and at the end of the semester, which also meant lower attendance than the instructor expected. This might mean that the data in this study is from predominantly certain types of students, increasing selection bias (Shadish et al., 2002). As a

result, any stereotype threat or anxiety results from this study could be inaccurate to the population of interest.

On the other hand, peers can influence stereotype threat and perceptions of the classroom (E. Smith & Farkas, 2023), and this dissertation study was conducted during actual class times with their normal peers and instructor nearby. Therefore, these characteristics of the study suggest that the results could have been amplified. Students in this study could also be subject to social desirability bias (Grimm, 2010), particularly in the classrooms that were organized into learning pods, such that their math assessment and survey responses were viewable by others around them. Instead of amplifying the effects of stereotype threat, this could lead to more neutral, devil-may-care responses. Inattentive responding, either from social desirability bias or from choosing to complete the surveys without deeply interrogating the meaning behind questions, could also lead to inaccurate results (Zorowitz et al., 2023).

Additionally, one particular identity was not able to be featured as much as expected in the qualitative portion of the study. Two students in the overall study identified as gay, but only one of them had written anything for the open-response questions. When he did, he did not mention his sexuality or other aspects of his identity in the response. There were nearly 9% of student participants who did not disclose their sexuality at all, indicating that there may be stories of gay students that were not told in this study due to the comfort level of the students disclosing their identity, responding to the open-questions, or both. The financial status of many students (23%) was also not disclosed, which may be why it was not clear that any level of financial stability had worse levels of anxiety or stereotype threat as compared to others – resulting in no particular students being pulled for qualitative analysis based on their financial status. These nondisclosures and minimal responses may also be a result of social desirability bias, which is a

sacrifice made when in a real classroom but could be additionally prevalent for gay or lower-income students who wish to keep that aspect of their identity hidden from their peers. Gender and racial identities can result in certain expressions, so most students may have been more comfortable disclosing those aspects of their identity. In future versions of a study like this, considerations need to be made by researchers so that the benefits of being in a real classroom or testing environment are optimized while social desirability bias, particularly for gay students, is minimized.

This study was designed for gathering data from students within their everyday classroom, and partially due to feasibility, all data is collected at the same point in time. This creates a limitation of this study because it prevents the ability to establish conceptually grounded temporal precedence (Karimi, 2010). Attempting to address this limitation would have meant sacrificing students' ability to feel anonymity and safety in their responses to the survey questions following the math assessment. This is not a sacrifice I was willing to make. Additionally, attempting to gather data at different time points – for example, if I were to collect data about anxiety on one class day and came back some time later to do a math assessment with more surveys after – might affect the anxiety experienced on the math assessment. Students may expect to feel anxious based on the questions they were asked previously. In all, the classroom was able to offer a more realistic setting to the study than experimental studies are often able to provide, but this also means the possibility of less authentic responses in these social settings. I suggest that future studies follow the lead of Good and colleagues (2008), who included the assessment in their study as a practice exam ahead of a real exam in class, by further embedding studies into real classroom environments to increase the authenticity of reactions. Additionally, I

suggest finding a way to reduce the effects of social desirability bias, perhaps by asking students to complete surveys outside of a learning pod setting.

Future Directions

In terms of sample, studies in higher education typically include Native American students as little more than an asterisk – representing so little of the population that they are aggressively aggregated into a group representing less than 1% or they are left out of a study entirely, replaced by an asterisk and a note (Shotton, 2013). This study had 8% of students identify as Native American (although some of them also identified as white). This is a huge number compared to many similar studies. I advise that researchers consider allowing open-response questions. Some of these students may identify as both white and Native American, so that closed-response, multiple-choice forms force them to choose between selecting "white" or "American Indian/Alaskan Native" options, if the second option is available at all. In fact, Native American students at the University of Oklahoma make up about 4% of the student population – graduate and undergraduate (*The Top 200 Colleges for Indigenous Students*, 2018), but the number of students who identified as Native American in this study suggests that there could be many more at the university who identify this way, but who are not included in reported data. Attendance during the study's data collection was low for many class sections, so I do not intend to imply that this study's sample is representative of the university. Rather, researchers should take care to include appropriate identifications in study's moving forward.

A future direction for me as a researcher will be to reanalyze the data from this study in two different ways. Guided by the above-mentioned need to honor the intersectional nature of students' identities, I plan to analyze the data by using an intersectional lens. Intersectionality is a theoretical framework which serves to acknowledge the multiplicative identities of gender, race

and ethnicity, class, ability status, sexual orientation, geographical location, language, and immigration status, among others (Collins et al., 2021; Crenshaw, 1989). Instead of creating policies and solutions that might address only one aspect of one group, an "either/or" approach to social justice, intersectionality calls for a "both/and" approach (Collins et al., 2021; Crenshaw, 1989; Evans-Winters, 2021). The stressors stemming from racialized-gendered experiences (which go beyond racialized or gendered experiences on their own) have unique effects on health and wellness for those from multiplying and marginalized identities (Bey et al., 2019). Analysis with an intersectionality lens might mean using latent profile analysis to consider the creation of homogenous groups based on similarities in aspects of their data (Spurk et al., 2020), which could include their social identities, survey item responses, math assessment performance, or classroom data (day of data collection, classroom setup, instructor gender presentation, etc.).

Another way to reanalyze this data is to assess only the Native American students in the study. Because this study had such a large number of Native American students – considering its topic of interest – coupled with the nature of quantitative data being typically aggregated or removed for this population in research settings (Shotton, 2013), it would be appropriate to take advantage of these numbers by assessing results of anxiety and stereotype threat for only this population as a standalone study.

As stated in the methodology chapter, this study is situated within precalculus math classrooms at The University of Oklahoma, and therefore it should not be assumed to easily transfer to other situations, populations, or environments.

Conclusion

This study was theoretically and methodologically distinct in that I used a CVT, SEVT, and QuantCrit lens to design and analyze a study with the purpose of beginning to disentangle

the relationship between stereotype threat and anxiety. This relationship, at this point, remains quite tangled. Gender-, race-, sexuality-, and income-based stereotype threats are able to predict levels of achievement anxiety – with predictions that may be conservative based on the situative aspect of the study. Additionally, achievement anxiety is able to be predicted by performance levels of real assessments, but not necessarily predict the assessment score in this study. Again, this result may be conservative, and tying research-related assessments to real-life stakes should be considered.

In challenging research and classroom norms, I suggest that students be aware of stereotypes that exist so that they may be refuted – introducing a stereotype nullification intervention. I additionally suggest that policy makers and higher education admin focus financial resources into mathematics classrooms at all levels – particularly for students who might not have these resources otherwise.

Looking forward, I recommend that researchers work to better assess levels of stereotype threat and design studies carefully through intersectional frameworks which employ the tenets of QuantCrit. I plan to reanalyze the data in this study through an intersectional lens and a portion of this data to assess the relationships between stereotype threat and achievement anxiety for Native American students.

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Appendix A – Math Assessment

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Directions: **For each question, indicate the best answer using the directions given.**
Notes: All numbers used are real numbers.

For Problems 1 – 3, compare Quantity A and Quantity B, using additional information centered above the two quantities if such information is given. Select one of the following four answer choices. A symbol that appears more than once in a question has the same meaning throughout the question.

A. **Quantity A is greater.**
B. **Quantity B is greater.**
C. **The two quantities are equal.**
D. **The relationship cannot be determined from the information given.**

Example:

Quantity A	**Quantity B**
$(2)(6)$	$2 + 6$

The correct answer choice for this example is (A). (2)(6), or 12, is greater than 2+6, or 8.

Problem 1:

$$(\boldsymbol{x - 2y})(\boldsymbol{x + 2y}) = \boldsymbol{4}$$

Quantity A	**Quantity B**
$x^2 - 4y^2$	8

A	B	C	D

Problem 2:

$$6 < x < 7$$
$$y = 8$$

Quantity A	**Quantity B**
$\frac{x}{y}$	0.85

A	B	C	D

Problem 3:

$$x \neq 0$$

Quantity A	**Quantity B**
$\lvert x\rvert + \lvert -2\rvert$	$\lvert x - 2\rvert$

A	B	C	D

Problems 4 – 10 are multiple choice or multiple answer with five answer choices. Select the best one of the answer choices given, unless told otherwise.

Problem 4: What is the least integer n such that $\frac{1}{2^n} < 0.001$?

10	11	500	501	There is no such least value

Problem 5: If a is the smallest prime number greater than 21 and b is the largest prime number less than 16, then $ab =$

299	323	330	345	351

Problem 6: If c and d are positive integers and m is the greatest common factor of c and d, then m must be the greatest common factor of c and which of the following integers?

$c + d$	$2 + d$	cd	$2d$	d^2

Problem 7: Last year Kate spent between 14 and 13 of her gross income on her mortgage payments. If Kate spent $13,470 on her mortgage payments last year, which of the following could have been her gross income last year?

Indicate all possible values.

$40,200	$43,450	$47,256	$51,966	$53,808

Problem 8: If j and k are integers and $j - k$ is even, which of the following must be even?

k	jk	$j + 2k$	$jk + j$	$jk - 2j$

Problem 9: If p is a negative number and $0 < s < |p|$, which of the following must also be a negative number?

$(p + s)^2$	$(p - s)^2$	$(s - p)^2$	$p^2 - s^2$	$s^2 - p^2$

Problem 10: The quantities S and T are positive and are related by the equation $S = kT$, where k is a constant. If the value of S increases by 50 percent, then the value of T decreases by what percent?

25%	$33\frac{1}{3}\%$	50%	$66\frac{2}{3}\%$	75%

Appendix B – Modified SVS

The following questions are about how you feel about your *gender identity* (for example – woman or gender fluid) and about how these feelings may affect your perceptions of your math ability. For some people, their gender is a major concern; for others it is less important. We would like you to consider your gender and respond to the following statements on the basis of how you feel about your gender. There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions.

1. The experimenters expected me to do poorly on the test because of my gender.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

2. The test may have been easier for people of my gender.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

3. I doubt that others would think that I have less math ability because of my gender.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

4. Some people feel I have less math ability because of my gender.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

5. People of my gender rarely face unfair evaluations in math classes.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

6. In math classes people of my gender often face biased evaluations from others.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

7. My gender does not affect people's perception of my math ability.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

8. In math classes I often feel that others look down on me because of my gender.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

The following questions are about how you feel about your racial identity (for example – Black or Latine) and about how these feelings may affect your perceptions of your math ability. For some people, their race is a major concern; for others it is less important. We would like you to consider your racial identity and respond to the following statements on the basis of how you feel about your race. There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions.

9. The experimenters expected me to do poorly on the test because of my race.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

10. The test may have been easier for people of my race.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

11. I doubt that others would think that I have less math ability because of my race.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

12. Some people feel I have less math ability because of my race.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

13. People of my race rarely face unfair evaluations in math classes.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

14. In math classes people of my race often face biased evaluations from others.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

15. Select the number 2 below to show attentiveness to the survey.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

16. My race does not affect people's perception of my math ability.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

17. In math classes I often feel that others look down on me because of my race.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

The following questions are about how you feel about your sexual identity (for example – lesbian or pansexual) and about how these feelings may affect your perceptions of your math ability. For some people, their sexual identity is a major concern; for others it is less important. We would like you to consider your sexual identity and respond to the following statements on the basis of how you feel about your sexual identity. There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions.

18. The experimenters expected me to do poorly on the test because of my sexuality.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

19. The test may have been easier for people of my sexuality.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

20. I doubt that others would think that I have less math ability because of my sexuality.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

21. Some people feel I have less math ability because of my sexuality.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

22. People of my sexuality rarely face unfair evaluations in math classes.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

23. In math classes people of my sexuality often face biased evaluations from others.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

24. My sexuality does not affect people's perception of my math ability.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

25. In math classes I often feel that others look down on me because of my sexuality.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

The following questions are about how you feel about your financial status and about how these feelings may affect your perceptions of your math ability. For some people, their financial status is a major concern; for others it is less important. We would like you to consider your financial status and respond to the following statements on the basis of how you feel about your financial status. There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions.

26. The experimenters expected me to do poorly on the test because of my finances.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

27. The test may have been easier for people of similar finances.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

28. I doubt that others would think that I have less math ability because of my finances.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

29. Some people feel I have less math ability because of my finances.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

30. People of my financial status rarely face unfair evaluations in math classes.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

31. Select the number 6 below to show attentiveness to the survey.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

32. In math classes people of my financial status often face biased evaluations from others.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

33. My financial status does not affect people's perception of my math ability.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

34. In math classes I often feel that others look down on me because of my finances.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

Appendix C – Modified AAQ

This questionnaire concerns your beliefs and opinions about the math assessment you just took. There are no right or wrong answers – we are simply trying to find out how you feel and think about the math assessment. We are interested in your personal opinions, so please be candid in your responses. Read each item carefully and respond using the scale provided.

1. I was worried I wouldn't be able to cope with the assessment.

Strongly Disagree	1	2	3	4	5	Strongly Agree

2. Worrying about not completing the assessment made me sweat.

Strongly Disagree	1	2	3	4	5	Strongly Agree

3. I got so nervous I wish I could have just skipped the assessment.

Strongly Disagree	1	2	3	4	5	Strongly Agree

4. I was worried that the test would be too difficult.

Strongly Disagree	1	2	3	4	5	Strongly Agree

5. Select the number 5 below to show attentiveness to the survey.

Strongly Disagree	1	2	3	4	5	Strongly Agree

6. At the beginning of the test, my heart started pounding.

Strongly Disagree	1	2	3	4	5	Strongly Agree

7. I was very nervous.

Strongly Disagree	1	2	3	4	5	Strongly Agree

Appendix D – Experience Survey

Please use the space below each question to give more details about your experience with the math assessment you were given at the beginning of this session. There are no right or wrong answers. We want to know your honest thoughts and opinions, so please feel free to be candid.

1. We acknowledge that survey scores may not give you the opportunity to express your full experiences. Is there anything else you'd like the researchers to know about your emotional experiences during the math assessment and your performance on it?
2. Do you think that your experience with the math assessment is typical for someone of your identity and experience? Please feel free to elaborate with as much detail as you would like the researchers to have about your true feelings.

Appendix E – Identity Questions

Please answer the following as you feel comfortable. If you choose not to disclose a certain identity, please select that option.

1. Gender Identity (For example – woman or gender fluid): _____
    - Choose not to disclose my gender identity.

2. Racial Identity (For example – Black or Latine): _____
    - Choose not to disclose my racial identity.

3. Age (in years): _____
    - Choose not to disclose my age.

4. Sexual Identity (For example – gay or pansexual): _____
    - Choose not to disclose my sexuality.

5. Please check each of the following financial sources that you use for your college expenses:
    - Federal Pell grants
    - Federal Study Loans
    - Private Loans
    - Choose not to disclose these financial sources.

Indicate the score you received on your most recently returned math assessment (quiz or exam):

7. I earned _____ out of _____ points.
    - Choose not to disclose my most recently returned math assessment score.

Indicate your choice of the following by selecting the appropriate choice.

8. I am good at math.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

- Choose not to disclose

9. It is important to me that I be good at math.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

- Choose not to disclose

If you are willing to be contacted later about clarifications on your open-response answers in the previous section, please provide your email address: _____.

Appendix F – Study Introduction Script

"My name is Casey Haskins, and I am a graduate researcher with the college of education. Thank you to your instructor and to you all for giving your class time today for me to introduce you to my current research study. In the provided manila envelopes, you will see a single sheet of paper – an informed consent information page – and a stapled packet. Please take a few moments to read the informed consent and decide if you'd like to participate in this study today. Engaging with the provided packet and answering the questions therein is your consent for me to use your data in the study. If you would not like to participate in the study, please do not answer ANY of the questions within. The study will ask you to take a short math assessment followed by some surveys. Once you are done reviewing the informed consent page, please wait quietly for further instruction."

After waiting for all to review the informed consent.

"Please now start at the beginning of the packet, read the instructions for the math assessment and answer the math assessment questions. You will have 10 minutes to work on 10 math problems. If you finish, please wait quietly for further instruction. I will wait outside the classroom for these 10 minutes, but will pop my head in to let you know when 10 minutes have passed and you may continue with the packet. You may begin."

PI leaves the room. After 10 minutes have passed, PI comes back, standing in the door.

"Whether you are done with the math assessment or not, please turn to the next portion of the packet, answering questions in order starting with the page immediately following the STOP symbol and continuing through the end of the packet. You do not need to wait to continue at any point. Answer questions in order through the end of the packet. When you are done please place the packet back into the manila envelope and grab a debrief document from the front of the room. If you then choose not to submit your answers to me, you may take the packet with you. Otherwise, please place the completed packet on the front desk of the room if you still wish to provide your data. You may keep the informed consent page and a copy of the debrief document. I will wait outside, and let you know when 1 minute is remaining."

PI leaves the room. With 1 minute left, PI comes back, standing in the door.

"Regardless of your progress in the rest of the packet, please now go to the very last page, which includes questions about your identity. Again, when you are done, you may grab a copy of the debrief document and after reading it, either choose to keep the packet and not submit your data, or put the packet back into your envelope and place it on the front desk of the room."

At the end.

"Thank you all so much for agreeing to participate today. To reiterate your debrief document, the math assessment that you took was intended to be challenging, and was intended to cause as much stress as a high stakes assessment might. Doing really well or really poorly on this assessment is not at all an indication of intelligence or math ability. Your status as a university

level mathematics student speaks very highly of your math success up to this point. Please refer to the informed consent page for my contact information if you have any questions about this study. Have a great day!”

Appendix G – Informed Consent Handout

Would you like to be involved in research at the University of Oklahoma?

I am Casey Haskins, a doctoral student from the Department of Educational Psychology, and I invite you to participate in my research entitled Emotions and Identity in Mathematics. You were selected as a possible participant because you are currently enrolled in a first-year mathematics course at the university. You must be at least 18 years of age to participate in this research.

Please read this document and ask any question you may have BEFORE agreeing to participate in my research.

What is the purpose of this research? This research aims to assess the relationships between identity and emotions on mathematics assessments.

How many participants will be in this research? Up to 400 first-year mathematics students will take part in this research.

What will I be asked to do? If you agree to be in this research study, you will be asked to take a short math assessment followed by closed-response and open-response surveys about how you feel about the math assessment and some demographic questions. You will have the option of providing your email address for follow-up questions, should you be willing to provide additional or clarifying information about your Responses.

How long will this take? Your participation will take about 30 minutes of class time.

What are the risks and benefits if I participate? I will ask you to answer questions that may make you distressed or trigger strong emotional reactions. If these questions make you feel uncomfortable, you do not have to provide an answer, or you can discontinue participation in the research. There are also resources for you that are available any time: https://www.ou.edu/ucc

You will be asked to provide demographic information that describes you. Different combinations of personal information may make it possible for your identity to be guessed by someone who was given, or gained access, to our research records. To minimize the risk of deductive re-identification, I will not combine entirely unique identifying variables, nor analyze and report results for these individuals alongside their demographic information.

Participation in this research requires social contact with the researcher. According to the CDC (www.cdc.gov), the virus that causes COVID-19 spreads easily and sustainably between people. This research protocol includes precautions that follow the CDC guidelines and comply with the current state and local restrictions on allowable personal interactions.

There are no benefits or compensation for participating.

Who will see my information? Research records will be stored securely, and only approved researchers and the OU Institutional Review Board will have record access. There is a social risk of participating in that deductive re-identification may be possible if an identity is unique in the dissemination of the analysis.

Do I have to participate? No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any questions and can stop participating at any time.

What will happen to my data in the future? We might share your (de-identified) data with other researchers or use it in future research without obtaining additional consent from you. Deductive re-identification may be possible if an identity is unique.

Who do I contact with questions, concerns, or complaints? If you have questions, concerns, or complaints about the research or have experienced a research-related injury, contact me at chaskins@ou.edu or my faculty sponsor (Dr. Alison Koenka) at koenkaac@ou.edu. You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

Please keep this document for your records. By providing information to the researcher(s), I agree to participate in this research.

Appendix H – Debrief Document

Thank you for participating in our study. In educational psychology research, it is sometimes necessary to conceal our intent and hypotheses because when people know what is being studied, they often alter their answers. However, we do not want you to leave misinformed, so we will now tell you what we were actually studying.

The purpose of this study is to learn about students' naturally occurring relationships between stereotype threat and anxiety in relatively authentic math assessment situations.

In order to test the hypotheses, you were given a math assessment that was intended to be challenging. It was intended to cause as much stress as a high stakes assessment might. Doing really well or really poorly on this assessment is not at all an indication of intelligence or math ability. Your status as a university level mathematics student speaks very highly of your math success up to this point.

We apologize that we could not reveal our true hypotheses to you up front, but we hope you can see why it was necessary to keep this information from you. When people know exactly what the researcher is studying, they often change their behavior, thus making their responses unusable for drawing conclusions about human nature and experiences. **For this reason, we ask that you please not discuss this study with other students who might participate anytime in the next year. Thank you for your cooperation.**

If your participation in this study has in any way upset you, please feel free to set up an appointment with one of OU's licensed psychologists or counselors. Counseling and Testing Services is located on the second floor of Goddard Health Center, and they can be reached at (405) 325-2911 or 325-2700. If you would not like to use one of OU's resources, you may also want to use SAMHSA's National Helpline, 1-800-662-HELP (4357), which is available 24/7.

If you have any questions about this study, feel free to ask the researcher (chaskins@ou.edu). Thank you for your help today.

Now that you know the true nature of the study, if you would like to not include your data, please take your packet with you.

Appendix I – Qualitative Codebook

The following codes were planned to be used in the initial analysis of the qualitative data. More codes were developed through thematic analysis.

Code	**Description**	**Possible Example**
Gender identity	The student brings up their specific gender identity in response to one or both of the questions	"As a woman . . ."
Racial identity	The student bring up their specific racial identity in response to one or both of the questions	"As a Native American . . ."
Sexual identity	The student brings up their sexuality in response to one or both of the questions	"As a queer-identifying math student . . ."
Income level	The student brings up their income-level in response to one or both of the questions	"Since I've had a hard time paying for school . . ."
Anxiety	The student uses words or phrases which indicate an anxious experience.	"Math tests always worry me."
Stereotype threat	The student uses words or phrases which indicate a concern that they will be stereotyped based on an aspect of their identity.	"I always feel pressured to prove people wrong about my math performance as a woman."

Appendix J – Listwise Deletion Statistics

Table of Listwise Deletion with Stereotype Threat Predictions of Achievement Anxiety

Relevant ST	R-square	F-statistic	p-value	Standardized beta
Gender	0.09	10.54	0.002	0.29
Sexuality	0.06	7.44	0.007	0.25

Note. ST stands for Stereotype Threat.

Appendix K – Sample Qualitative Analysis Profile

Participant ID	1D
Instructor Gender	Woman
Class Type	1503
Classroom Type	Active Tables
Class Day	Friday
Class Time	Lunch
Gender Identity	woman
Racial Identity	Black
Age (years)	18
Sexual Identity	heterosexual
Pell Grant/GI Bill?	Yes
Federal Student Loans?	Yes
Private Loans?	No
Last Assessment Score %	80.5%
Math Assessment	2 correct, 8 incorrect, 0 blank
Gender-Based ST	3 – 5 – 7 – 4 – 4 – 3 – 6 – 2
Race-Based ST	3 – 5 – 5 – 5 – 4 – 4 – 3 – 4
Sexuality-Based ST	3 – 4 – 4 – 4 – 6 – 2 – 6 – 2
Income-Based ST	3 – 5 – 5 – 4 – 4 – 3 – 6 – 2
Anxiety	2 – 1 – 2 – 3 – 2 – 1
I am good at math.	5
It is important that I be good at math.	7
We acknowledge that survey scores may not give you the opportunity to express your full experiences. Is there anything else you'd like	I just usually panic when I know that there's an assessment nearing, but I find ways to calm myself down before I start.

the researchers to know about your emotional experiences during the math assessment and your performance on it?	
Do you think that your experience with the math assessment is typical for someone of your identity and experience? Please feel free to elaborate with as much detail as you would like the researchers to have about your true feelings.	Knowing the people I know, we all usually have the same experience when it comes to assessments. I can't speak for everyone, but we usually get anxiety but then try to diminish it by the time we're in the middle of the assessment
Reason for Qualitative Analysis of This Participant	women had more Gender-based ST than men, Black students had more Race-based ST than white or Native American students

Appendix L – Triangulation Instructions

In coding, please do not edit the document – you should only use comments for coding. Keep codes concise (less than a sentence), but feel free to reply to your comment with additional notes about what your code means, if you think it needs clarification.

Open-Response Items (Priority)

- If the question "We acknowledge that survey scores may not give you the opportunity to express your full experiences. Is there anything else you'd like the researchers to know about your emotional experiences during the math assessment and your performance on it?" is answered, leave a comment (or multiple comments, if needed) with how you would choose to code their response in an open-coding analysis which focuses on the relationship between anxiety and stereotype threat.
- If the question "Do you think that your experience with the math assessment is typical for someone of your identity and experience? Please feel free to elaborate with as much detail as you would like the researchers to have about your true feelings." is answered, leave a comment (or multiple comments, if needed) with how you would choose to code their response in an open-coding analysis which focuses on the relationship between anxiety and stereotype threat.
- A note: Don't think too hard about re-using codes. Do what feels natural for each individual student's response, and I'll worry about pulling down into themes later.

Stereotype Threat Quantitative Responses (Secondary)

- If a student preferred to answer at the extremes (0/1 = strongly disagree and 7/8 = strongly agree) many students likely answer the questions as 1-1-7-1-7-1-7-1 or 0-0-8-0-8-0-8-0.

- Some students had a similar, but slightly altered pattern (perhaps due to how they interpreted a question or how they like to answer Likert-type scales), but still stuck to their own pattern for each (or most) of their identity-based stereotype threat questions.
- If one identity-based stereotype threat line sticks out to you, leave a comment with what sticks out and what you think it could mean. The questions are at the bottom of the document, and you may relate your thoughts to anything within the document as well (their level of anxiety, their other pieces of identity, their answers to the open-response items).

Additional comments (Very Optional)

- Feel free to add a code (as a comment) which summarizes your thoughts on this student OR an additional thought that comes to mind.

Appendix M – Complete Qualitative Codebook

Code	Explanation
Theme 1: Explanations for Performance or Emotion (21 students)	
• *Difficulty understanding the questions (4 students)*	• *Their performance or their emotion was because they did not understand the wording or the purpose of the questions on the assessment.*
• *Less educated (4 students)*	• *Their performance or emotions are a consequence of being less educated in mathematics (for a variety of reasons).*
• *Limited time (4 students)*	• *Their performance or emotions on this assessment were due to having limited time on it.*
• *Assessment was not expected (3 students)*	• *Their performance or emotions were due to not being prepared for the assessment ahead of time.*
• *Course design (3 students)*	• *Their performance or emotions might typically be due to something about the course design or protocols in the course.*
• *Effort (2 students)*	• *Performance or emotions in general depend upon how much effort a student puts into the course.*
• *Teacher/Teaching (2 students)*	• *Performance or emotions in general depend upon the teacher's ability to teach or the student's ability to understand the teacher*
• *Classroom atmosphere (1 student)*	• *"It's the class atmosphere that makes or breaks a student . . . "*
• *Insecurities magnify negative experiences (1 student)*	• *"My own insecurities may magnify the negative experiences I have faced in learning math."*
• *Not refreshed on topics (1 student)*	• *Similar to "assessment was not expected", their performance or emotions were due to not being refreshed on the topics of the assessment.*
• *Identities can add stress (1 student)*	• *Additional stress in performance could be due to identity, but the performance itself is not.*
• *Taking classes higher than readiness (1 student)*	• *Performance or emotions could be due to not feeling ready for the content on an assessment.*

Theme 2: Negative Emotions (20 students)	
• *Testing anxiety (7 students)*	• *Made reference to being anxious during tests, though may not have been anxious during this test.*
• *Nervous (5 students)*	• *Made a reference to being nervous during the assessment that day, and potentially being nervous from any assessment.*
• *Anxiety is normal (4 students)*	• *They think that their emotional experience on this assessment is typical for someone of their identity (math or social) and that the typical experience includes anxiety.*
• *Implied anxiety given the right settings (4 students)*	• *They may not have felt anxious about this assessment, but made it sound like this assessment was the exception to the rule.*
• *Normalizing experience (3 students)*	• *These students indicate that their experience is completely normal, whether it be anxiety, struggle with content, or otherwise not enjoying mathematics.*
• *Anxious and overwhelmed (2 students*	• *They indicated that it is more than moderate levels of stress on this assessment or on assessments in general.*
• *Anger and stress (2 students)*	• *They indicate that it is more than stress alone that is an extreme emotion during assessments, including anger.*
• *Attempts to diminish anxiety – 1 student*	• *This student makes active attempts to diminish anxiety.*
• *Scared (1 student)*	• *They referred to the assessment as scary.*
• *Worried about embarrassment (1 student)*	• *They were worried about potential embarrassment from their performance on the assessment*
• *Clueless and lost (1 student)*	• *They refer to feeling clueless and lost during the assessment.*
• *Anxiety (1 student)*	• *Not necessarily referring to testing anxiety or math anxiety, this student refers to regular struggles with anxiety, in general.*

• *Anxiety – time factor (1 student)*	• *As opposed to being anxious during the exam itself, this refers to feeling anxious when an assessment is about to happen.*
• *Minimizing anxiety (1 student)*	• *They not only feel anxiety on this assessment, they feel anxiety in all assessments. They indicate some form of minimizing their anxiety on assessments because they are used to feeling it on all assessments.*
• *Possible anxiety (1 student)*	• *They do not say specifically that they are anxious, but describe some anxiety-related experiences.*
• *Lack of enjoyment (1 student)*	• *They discuss this assessment in context of their typical mathematics enjoyment, which they do not enjoy.*
• *Normalizing lack of enjoyment (1 student)*	• *They discuss this assessment in context of other students' typical mathematics enjoyment, which this student indicates many do not enjoy.*
Theme 3: It's not about identity (18 students)	
• *Identity has nothing or very little to do with ability, or vice versa (15 students)*	• *Refers to their belief that identity and ability are not correlated.*
• *Performance and emotions are more about experience than identity (4 students)*	• *They do not explicitly say that they believe identity has nothing or very little to do with ability, or not ONLY say it, but instead (or additionally) mention that there's something besides a connection to identity that is correlated with ability and emotion. Often, they refer to mathematical backgrounds.*
• *Everyone has different backgrounds (3 students)*	• *They do mention explicitly that they think mathematical or social background (but not identity) leads to different experiences and struggles in mathematics.*
• *Everyone has different minds (1 student)*	• *Similar to having a different background, this refers to differing minds which leads to different experiences and struggles in mathematics.*
• *Finances have nothing to do with math (1 student)*	• *They refer to finances (not mentioning the other identities in the surveys) as not having anything to do with ability or emotions.*

Theme 4: Identity Comparisons (18 students)	
• *Comparisons to others (11 students)*	• *They refer to other students, either in the interest of comparing themselves to people in their identity group or outside of it.*
• *Stereotype about race (2 students)*	• *Refers to a positive or negative stereotype about their identity group.*
• *Gender and race identity (1 student)*	• *Indicates that their experience is typical for those in their combined gender and race identity group.*
• *Identity is not their fault (1 student)*	• *Refers to people in their identity group, but that belongingness to these groups are not chosen, but imparted by society or others upon them.*
• *Non-Typical experience for race (1 student)*	• *They think that their experience is not typical for someone in their racial identity group.*
• *Not sure of comparison (1 student)*	• *They are not sure that their experience is typical for someone in their particular identity group, including their particular race, socioeconomic status, gender, and sexuality.*
• *Race identity (1 student)*	• *They think that their experience is typical for someone in their racial identity group.*
• *Gender identity (1 student)*	• *They think that their experience is typical for someone in their gender identity group.*
• *Identity informs ability (1 student)*	• *They think that their experience is typical for someone in their identity or experience group, and that their experience includes math being difficult.*
• *Inter-community expectations (1 student)*	• *They made comparisons to members of their identity group in terms of what is expected within the community made up of those in that identity group.*
Theme 5: Neutral emotions and experiences (14 students)	
• *Low stakes assessment (7 students)*	• *Refers to the fact that this assessment was low stakes and not for a grade, which is why they had neutral emotions or had no emotional stress/anxiety.*

• *Typical experiences (6 students)*	• *They think that their experience is typical for someone of their background, but either did not specify in what way that is, or mentioned something about the assessment as to what it is that is typical for someone in their identity group(s).*
• *No emotional stressors (5 students)*	• *Specifically indicated that they did not experience emotional stressors during the assessment.*
• *Easy test (1 student)*	• *They implied that there were no emotional stressors because the test was easy.*
• *Less nervous (1 student)*	• *They indicated that they are less nervous than others in their identity on this assessment, implying that people in their identity group are typically nervous.*
• *Performance was fine (1 student)*	• *They implied that there were no emotional stressors because they performed well enough on the assessment.*
• *Neutral experience (1 student)*	• *They indicated that they typically have a neutral experience with math learning, even though they have negative experiences and insecurities in assessments.*
Theme 6: Math Ability (13 students)	
• *An academic identity (5 students)*	• *Indicated that some part of their identity includes their math ability.*
• *Not good at math (3 students)*	• *Mentions that they are not good at or skilled in math.*
• *Math is difficulty (2 students)*	• *Without necessarily indicating their skill level in mathematics, the student indicates that the subject of mathematics is difficult.*
• *Math ability (2 students)*	• *These students connected their math ability specifically to the emotion they were experiencing.*
• *Tries (1 student)*	• *Implied that they do not think they are good at mathematics by indicating that they "do try" in their classes.*
• *Average ability (1 student)*	• *They indicate that they have an average ability in mathematics.*

• *Higher math background than the test (1 student)*	• *They do not mention being good or bad at math but mention that their math background is at a higher level than the assessment given this day.*
• *Cares about ability (1 student)*	• *They do not mention being good or bad at math but mention that they care about their abilities in math.*
Theme 7: Changes during the assessment (6 students)	
• *Better after it started (1 student)*	• *This student was nervous then was able to calm down during the assessment.*
• *Gave up (1 student)*	• *This student determined that they would not be able to finish the assessment correctly, so did not complete the assessment on purpose.*
• *Regret participation (1 student)*	• *Completed the assessment, but emotions changed based on survey questions. Indicated that the survey questions caused regret of participation entirely.*
• *Learning experience (1 student)*	• *This student felt that they were able to learn through the assessment.*
• *Tried their best (1 student)*	• *This student did not know what to do on the assessment questions but continued trying throughout their allotted time.*
• *Headache (1 student)*	• *This student got a headache from the effort (or focus) of the assessment, though they think it was not from the focus alone.*
Theme 9: Positive Emotions and Experiences (2 students)	
• *Enjoyment (1 student)*	• *Enjoyed figuring out how to solve the problems on the assessment.*
• *Love (1 student)*	• *Indicates a love for math, in general.*